GRID DEPLOYMENT OFFICE

Department of Energy's 2023 National Transmission Needs Study

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November 8, 2023

Transcript of webinar has been edited for clarity and accuracy.

Webinar Notice

- None of the information presented herein is legally binding.
- The content included in this presentation is intended for informational purposes only relating to the 2023 National Transmission Needs Study.
- Any content within this presentation that appears discrepant from the Needs Study language is superseded by the Needs Study language.

Hello, everyone, and welcome to the 2023 National Transmission Needs Study Webinar. I'm Whitney Bell with ICF, and I'll be your host today.

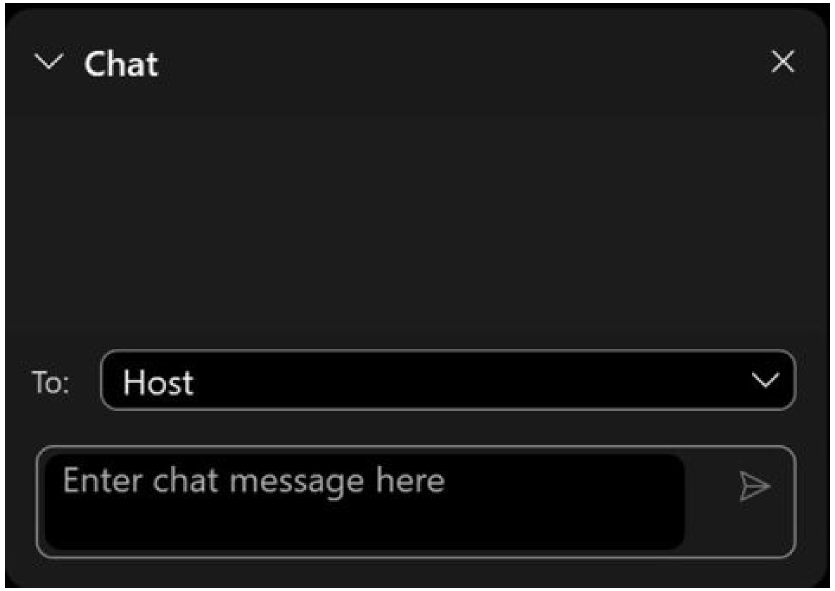
First, I've got a few things to share with you before we get into the webinar. None of the information presented herein is legally binding. The content included in this presentation is intended for informational purposes only relating to the 2023 National Transmission Needs Study.

Lastly, any content within this presentation that appears discrepant from the Needs Study language is superseded by the Needs Study language.

Housekeeping

Technical Issues?

If you have technical questions – please put them in the chat box for the host.



And now just a few housekeeping items. This Webex meeting is being recorded and may be used by the US Department of Energy. If you do not wish to have your voice recorded, please do not speak during the call. If you do not wish to have your image recorded, please turn off your camera or participate by phone. If you speak during the call or use the video connection, you are presumed consent to recording and use of your voice or image. Luckily for you, everybody is muted.

Menti

If you have any technical issues or questions, you may type them in the chat box and select Send to Host. If you need to view the live captioning, please refer to the link that will appear in the chat now.

We are going to be taking some questions today, so you may submit your questions throughout the event using Menti. We encourage you to go to Menti.com using your computer or your mobile device and enter the code that is on the screen. 96870310. You can then enter your questions throughout the event as our presenters go through their presentation.

You do have the option to up-vote some of the questions that you see. So, if you like them, the questions will move higher up in the queue for us to ask when we get to the Q&A. To ensure the most effective use of the like function, duplicate questions will not appear in the Menti interface. The link and the code to join us should be in the chat now. I'll go over this again when we get to the Q&A as well.

Maria Robinson

Director,
Grid Deployment Office,
U.S. Department of Energy

All right, so to kick off today's meeting, you'll hear from Maria Robinson, the Director of the Grid Deployment Office, for some opening remarks. So, let's go ahead and get started. Maria, welcome.

MARIA ROBINSON: Thank you, Whitney, so much. Good afternoon-- or good morning, I guess, to some. My name is Maria Robinson, and I am the Director of the Grid Deployment Office here at the US Department of Energy. And I'm delighted to welcome you all today to our webinar briefing on the National Transmission Needs study, which is formally known as the National Electric Transmission Congestion Study, DOE's triennial state of the grid report. The Needs Study provides insight into where the grid and, of course, American communities, would benefit from increased transmission by assessing both current and anticipated future capacity constraints and congestion on the nation's grid.

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DOE's Grid Deployment Office

Mission Statement: The Grid Deployment Office (GDO) works to provide electricity to everyone, everywhere by maintaining and investing in critical generation facilities to ensure resource adequacy and improving and expanding transmission and distribution systems to ensure all communities have access to reliable, affordable electricity.

Power Generation Assistance Division	The Power Generation Assistance Division works with existing generation facilities to ensure resilience and reliability.
Transmission Division	The Transmission Division supports innovative efforts in transmission reliability and clean energy analysis and programs, and energy infrastructure and risk analysis in support of the Administration's priorities to enhance grid resilience.
Grid Modernization Division	The Grid Modernization Division oversees activities that prevent outages and enhance the resilience of the electric grid.

A little background on the Grid Deployment Office. In addition to the Needs Study discussed today, we're advancing the Biden-Harris administration's grid and transmission goals and expanding access to affordable, reliable electricity across the country through a number of initiatives.

In September we released an Atlantic Offshore Wind Transmission plan which addresses offshore wind transmission challenges for the Atlantic coast and outlines a series of short-term and long-term recommendations to connect Atlantic Offshore Wind projects to the grid.

We've also begun to announce the first round of selections from the Bipartisan Infrastructure Law and the Inflation Reduction Act programs. This includes a commitment of up to $1.3 billion for three transmission projects from the Transmission Facilitation Program that can add up to three and a half gigawatts of additional grid capacity and create more than 13,000 high-quality direct and indirect jobs.

We've also given out $3.5 billion to 58 projects across 44 states from our Grid Program, representing the single largest direct investment in the grid in our nation's history. And of course, we've given out more than $748 million directly to states, tribes, and territories, to strengthen and modernize the electric grid against wildfires, extreme weather, and other natural disasters.

We're really proud of the progress that we've made thus far. But we're just getting started. The Needs Study is going to serve as the backbone of our work moving forward, underscoring high-priority national transmission needs and identifying where new or upgraded transmission facilities could alleviate congestion caused by an increase in renewables, or transportation, or building electrification, an increase in load, and just insufficient transfer capacity across regions, particularly in weather-dependent areas.

The Needs Study is also the basis for the designation of National Interest Electric Transmission Corridors, which we call NIETCs. We will be releasing further guidance on the NIETC designation process by the end of this year.

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Dr. Adria Brooks

Senior Technical Advisor, Transmission Planning
Grid Deployment Office
U.S. Department of Energy

Jesse Schneider

Policy Advisor, Transmission Planning
Grid Deployment Office
U.S. Department of Energy

I wanted to thank everyone who participated in the process of developing this study. Our team has certainly worked very closely with industry, with state and local governments, tribes, and policymakers across the country to understand where and how much transmission we need in the United States to ensure that power comes on with the flip of a switch and that the cost of electricity is affordable.

Your partnership and collaboration have been invaluable, and we really look forward to your continued collaboration as we use these findings to inform our future work on transmission. I also want to give a special thanks to our incredible team here at the Grid Deployment Office especially, Dr. Adria Brooks, Jesse Schneider, Molly Roy, Gretchen Kershaw, Jeff Dennis, John Gajda, and everyone else in the Transmission Division, for their tireless work to develop this study.

So, I'll turn it back over to Whitney to introduce Jesse and Dr. Brooks for a full briefing on the need study.

WHITNEY BELL: Thank you so much, Maria. So, as she just said, we'll now hear from Dr. Adria Brooks, Senior Technical Advisor in Transmission Planning with the Grid Deployment Office, and Jesse Schneider, Policy Advisor in Transmission Planning with Grid Deployment Office.

So, Jesse, I'll go ahead and turn this over to you first. Welcome.

Agenda

1. **Background**
2. **Overview of Study**
3. **Select Results**
4. **Questions & Answers**

https://www.energy.gov/gdo/national-transmission-needs-study

JESSE SCHNEIDER: Great. Well, thank you very much, Whitney. And thank you, Maria.

Today I will be walking through a handful of agenda items here today. First, I'll give a quick background of the Needs Study and the statutory language that drives the Department to conduct the study. I'll provide an overview of study structure itself before moving on to some select higher-level results of the study before I hand things over to my colleague, Dr. Adria Brooks, who will take a deeper dive into the study findings themselves. She will then field questions as part of a question-and-answer session at the end of this webinar.

We've also provided a link to the Needs Study here, which is posted on the GDO web page.

Background

Overview of National ~~Congestion~~ Needs Transmission Study

as amended by Bipartisan Infrastructure Law

Federal Power Act §216(a) directs DOE to conduct assessments of:

historic *and expected* transmission *capacity* constraints and congestion

every three years

with consultation* from States, *Indian tribes,* and regional grid entities

Serves as the Department's triennial state-of-the-grid report

consultation = ability to contribute to Study draft as referred to in Federal Power Act; NOT government-to-government *Consultation* with Tribes as defined by DOE Order 144.1

Beginning with our background. The Needs Study is a report that is statutorily required under Section 216A of the Federal Power Act, which directs the Department to conduct an assessment of historic transmission constraints and congestion every three years on the grid in consultation with a handful of entities. Notably, the states and the regional grid entities.

As you'll note here by the additions of red text, there are some changes to the Federal Power Act Section 216 in response to Congress's direction in the Bipartisan Infrastructure Law. In that historic bill, Congress amended section 216A to direct the Department not only to conduct an assessment of historic but also expected, transmission capacity constraints and congestion every three years, with the addition of consultation with the Indian tribes.

As Maria mentions, this was previously referred to as the National Transmission Congestion Study, and now referred to as the National Transmission Needs Study or the Needs Study for short. This serves as the Department's triennial State of the Grid Report.

And so, what we wanted to do here is emphasize, as the Department has continued to do throughout the development of the study, what the study is intended to accomplish and what it should not be misunderstood as doing.

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Understanding the Needs Study

	What It Is	What It Isn't
Objective	Assessment of Needs	Not prescribing solutions
Methods	Considers published data and reports (180 references)	No new modeling, cost-benefit analysis, or system planning
Output	Needs organized by geographic regions	Regions not synonymous with corridors

Here we clarify three things. Study objective, study methods, and study output. The objective is to identify pressing transmission needs across the nation. However, this study does not prescribe any specific transmission solutions to meet those needs.

For our methods, the Department has considered existing data, nearly 180 recently published reports from a variety of different entities, as well as capacity expansion modeling results from existing studies as well. The report, however, does not conduct any new modeling, cost benefit analyses, or system planning, which would occur at the industry-led transmission planning process level and elsewhere, not including other planning studies that the Department and others are undertaking.

And finally, study outputs. The Department assesses the data and we organize the findings by geographic region in the continental United States, as well as Alaska and Hawaii. However, these regions are not synonymous with National Interest Electric Transmission Corridors, or NIETCs. And this study does not identify or designate any NIETCs. The DOE will conduct corridor identification and designation in a separate process.

2023 Needs Study Outreach & Engagement

NOTICE OF INTENT Building a Better Grid

Jan/Feb 2022
- Federal Register
- Public webinar

PRELIMINARY NOTIFICATION

March 2022
- National State Association meeting
- DOE Tribal Consultation webinar

FORMAL NOTIFICATION

July 2022
- Tribes, states, regional grid coordinators
- National State Association conferences

CONSULTATION* DRAFT RELEASED

October 2022
- Tribes, states, regional grid coordinators

CONSULTATION* PERIOD

October-November
- Webinar and calls open to consultation entities
- Written or verbal comments received
- 20 entities provided ~180 unique comments

PUBLIC DRAFT RELEASED

February 2023
- Tribes, states, regional grid coordinators & public

PUBLIC COMMENT PERIOD

Feb - April 2023
- Public webinar
- Written comments accepted
- 58 entities provided ~330 unique comments

FINAL STUDY

October 2023

We want to highlight a little bit about the engagement and outreach to date on this study. Beginning with the announcement of the efforts in our Notice of Intent for our Building a Better Grid Initiative– issued January of 2022-- where the Department announced a handful of initiatives and efforts it would be undertaken, including this National Transmission Needs Study.

We notified the consultation entities that the Department is required to consult with in March and sent out a formal notification letter to those same entities in July of 2022.

The Department released a draft version of this report to those same consultation entities in October of 2022, and then held a consultation period through November the same year, where the Department did a couple of things. We held webinars and held calls with those same entities to field any questions about the report and to further discuss those draft study findings.

We received 20 entity submissions composing nearly 180 unique individual comments over that period. The Department worked to incorporate a lot of the feedback received and made a number of changes in response.

We later released a public draft at the end of February of 2023 and held a public comment period through April the same year. Again, we received a number of written comments during that public comment period--submissions from 58 entities composing roughly 330 unique individual comments. And again, the Department worked to incorporate a lot of the feedback we received there.

We finally released the final study on October 30th, just the other week.

****consultation* = ability to contribute to Study draft** as referred to in Federal Power Act; NOT government-to-government *Consultation* with Tribes as defined by DOE Order 144.1

Indicates new (or significantly updated) from public draft Study →

How will this Needs Study be used?

1 **Informs designation of National Interest Electric Transmission Corridors** (NIETC)

- The Needs Study does not designate any NIETCs.
- Designation considers Needs Study and many other statutory factors (FPA §216).

2 **Informs Department transmission priorities** and can support the implementation of funding programs, technical assistance and broader transmission planning activities

3 **Encourages planning entities to revise their planning processes** to consider a wider range of transmission benefits, portfolios instead of individual projects, scenario-based planning, longer planning horizons, alternative transmission solutions, and weather data which better reflects future extremes.

4 **Encourages state policymakers to incorporate findings into regulatory processes** through coordination with neighboring states, active participation in planning authority processes, and state-led solicitations for transmission.

Before we move on to the content of this slide, we want to direct your attention to the green colored star in the upper right-hand corner, which indicates whether the content we're presenting on the current slide is either entirely new or a significant update since the public draft of the study.

Moving on to the content. We clarify in the Needs Study, with the introduction of new language, how this Needs Study is intended to be used and how the Department aims to use the study.

We clarify four things here. The first, we clarify that the Needs Study findings will inform National Interest Electric Transmission Corridors, or NIETCs. However, this study does not designate any NIETCs. NIETC designation would consider Needs Study findings as well as other statutory factors outlined in section 216 of the Federal Power Act.

Additionally, the Department clarifies that the new study findings are intended to inform Department transmission priorities, including the implementation of funding programs, technical assistance, or broader transmission planning activities.

We also clarify that this Needs Study is not intended to supplant or presuppose any existing transmission planning activities, but rather, we encourage planning entities to revise their planning processes to incorporate these findings, including consideration of a wider range of transmission benefits, portfolios of transmission project evaluation-- rather than individual project evaluation-- scenario-based planning with longer planning horizons that incorporate alternative transmission solutions-- including grid enhancement technologies-- as well as weather data which better reflects future extremes.

And finally, we also encourage state policymakers to incorporate the findings into their respective regulatory processes as well.

Overview of Study

National Transmission Needs Study

Executive Summary
I. Introduction
II. Legislative Language
III. Transmission Concepts
IV. Current Transmission Need Assessment through Historical Data
V. Current and Future Need Assessment and Identification of Transmission Benefits through Review of Existing Studies
VI. Anticipated Future Need Assessment through Capacity Expansion Modeling
VII. Process for Preparing the 2023 Needs Study
A. National and Regional Fact Sheets
B. Comment Synthesis & Resolution

https://www.energy.gov/gdo/national-transmission-needs-study

Moving on to an overview of the study structure, the Needs Study is a seven-section report with two appendices. It's roughly 300 pages in length. We also publish on the website in a separate document Supplemental Material which outlines a lot of the methodology behind the department's analysis.

So, to begin with, an executive summary and introduction. We incorporate section II, which introduces some legislative language, including the Federal Power Act language that motivates the Department to conduct the study.

Section III is a discussion of transmission concepts as the Department touches on a handful of these at great length in the report, and we want to catch all readers up to speed.

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National Transmission Needs Study

Executive Summary
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  A. National and Regional Fact Sheets
  B. Comment Synthesis & Resolution

https://www.energy.gov/gdo/national-transmission-needs-stud

Sections IV through section VI really contain the majority of the findings of the report.

Section IV is a discussion of historical data, which the Department uses to assess current transmission needs.

Chapter V is a discussion and review of nearly 180 recently published reports from a variety of entities that the Department uses to assess current, as well as future, needs and the identification of transmission benefits.

Chapter VI is an assessment of existing capacity expansion modeling results, which the Department uses to assess anticipated future need.

Chapter VII is an overview of the process for preparing this 2023 Needs Study, including a lot of the language that we've already covered in the previous slide on engagement and outreach.

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National Transmission Needs Study

https://www.energy.gov/gdo/national-transmission-needs-stud

Appendix A is a selection of regional fact sheets for each geographic region assessed in the study, as well as the nation overall, which synthesizes the findings included in the body of the report. Appendix B is a comment synthesis and resolution in which the Department synthesizes the comments received over the public comment period and provides a discussion of how the Department chose to respond to those comments in the final study itself.

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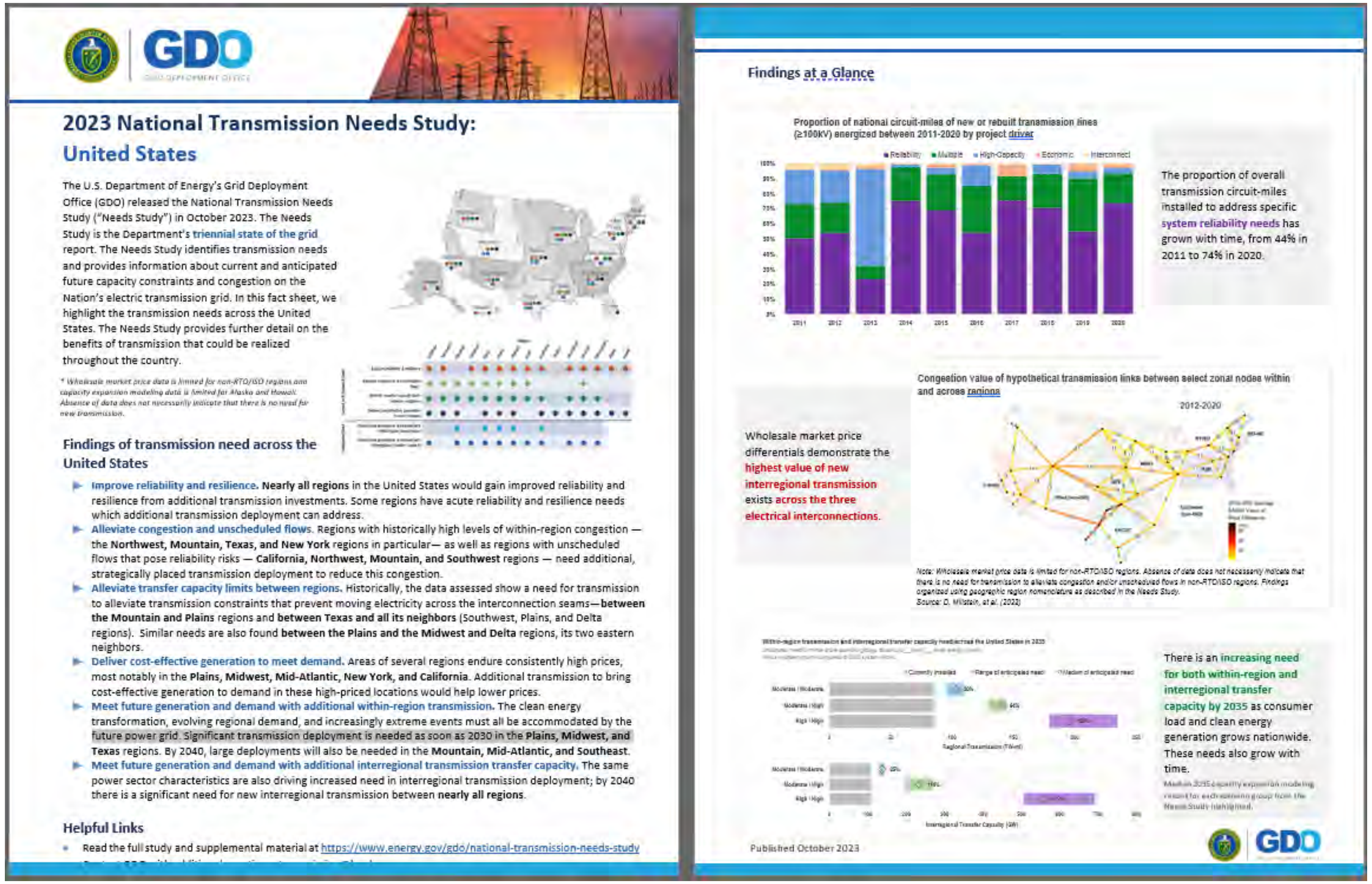
Appendix A: National and Regional Fact Sheets



A quick snapshot of those two appendices. Appendix A-- again, there are fact sheets for each region identified in the study, as well as the nation. They do not present any new information. They are simply a synthesis of the existing results in the study themselves. We also include some helpful graphics alongside these findings.

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Appendix B: Comment Synthesis & Resolution

National Transmission Needs Study

Public Comment Synthesis

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Appendix B, again, is a synthesis of all public comments received over the public comment period. It is organized by topic area, and we provide a discussion of Department response to those comments.

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Select Results

National Takeaways

1. There is a pressing need for new transmission infrastructure.
2. Interregional transmission results in the largest benefits.
3. Needs will shift over time.

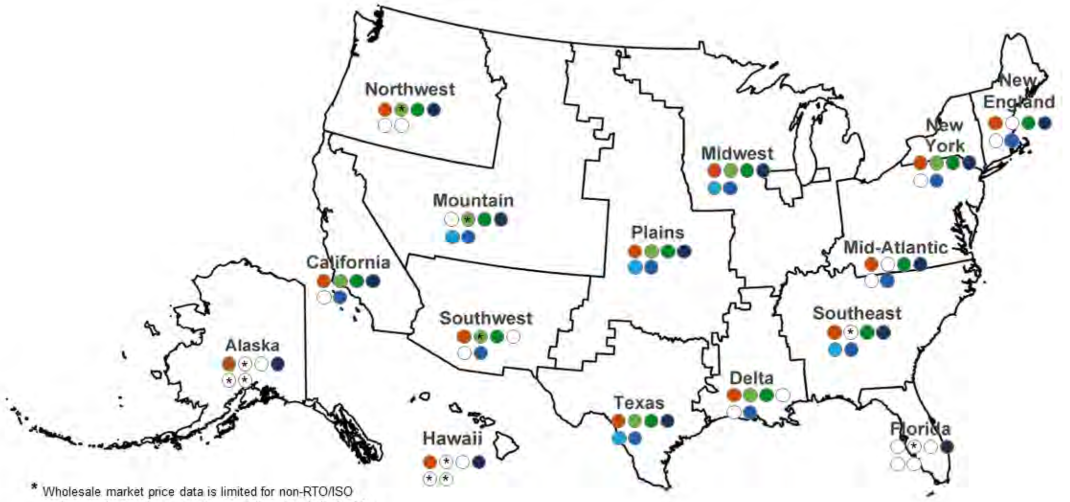
Moving on to some high-level results here. We have a couple of National takeaways.

We find that there's a pressing need for new transmission infrastructure.

We find that of all the different configurations of transmission deployment, that interregional transmission results in the largest benefits.

And that transmission needs will shift over time.

Executive Summary provides visual summary of national and regional findings of need.



* Wholesale market price data is limited for non-RTO/ISO regions and capacity expansion modeling data is limited for Alaska and Hawaii. Absence of data does not necessarily indicate that there is no need for new transmission.

Current or Anticipated Need:

- Improve reliability and resilience
- Alleviate congestion & unscheduled flows
- Alleviate transfer capacity limits between neighbors
- Deliver low-cost generation to high-priced demand

Anticipated Need:

- Meet future demand with within-region transmission
- Meet future demand with interregional transfer capacity

The Executive Summary provides a visual overview of the national and regional specific findings of the detailed Needs Study. We organize these findings by geographic region here, where a transmission need exists and could benefit from an upgraded or new transmission facility to meet the following six categories of need, which are included below this map.

The graphic uses these color-coded buckets-- these buckets are the higher-level buckets of transmission need used to categorize all need in the Needs Study. And these needs are color coded to the circles, or indicators of need, on the map underneath the labelings for each geographic region. And in the event that the Department has determined one of these high-level needs exists, we have color coded that need.

And so we just want to walk through these one by one. And again, these findings are just high-level summaries; the detailed findings are in the body of the report itself.

The need to improve reliability and resilience is indicated by the orange, or rust-colored, circle here. We find that nearly all regions in the United States would gain improved reliability and resilience from additional transmission investment.

The need to alleviate congestion and unscheduled flows is indicated by the lighter-colored green circle here. We find that regions with historically high levels of within-region congestion-- so the Northwest, the mountain, Texas, the New York regions in particular-- as well as regions with unscheduled flows that pose reliability risks-- like California, the Northwest, mountain, and Southwest regions-- need additional strategically placed transmission deployment to reduce this congestion.

Moving onto the need to alleviate transfer capacity limits. We find that, historically, the data assessed shows a need for transmission to alleviate capacity constraints that prevent moving electricity across the interconnection seams. So specifically, we find this need between the Mountain and the Plains regions, and between Texas and its neighbors (the Southwest, Plains, and the Delta regions). We also find a similar need exists between the Plains and the Midwest regions and between the Plains and the Delta regions.

Finally, the need to deliver low-cost generation to high-price demand. There are several regions that endure consistently high electricity prices, most notably areas within the Plains, the Midwest, the mid-Atlantic, New York, and California. And we find additional transmission to bring cost-effective generation to meet demand in those high-price locations would help lower prices.

And then finally, the need to meet future demand within region transmission, and the need to meet future demand with inter-regional transfer capacity. We find that to meet these future demands of the grid, as soon as 2030, there is significant need for within region transmission in the Plains, Midwest, and Texas regions. And then a need for interregional transfer capacity is found between the Delta and the Plains region, the Midwest and the Plains region, and the mid-Atlantic and the Midwest.

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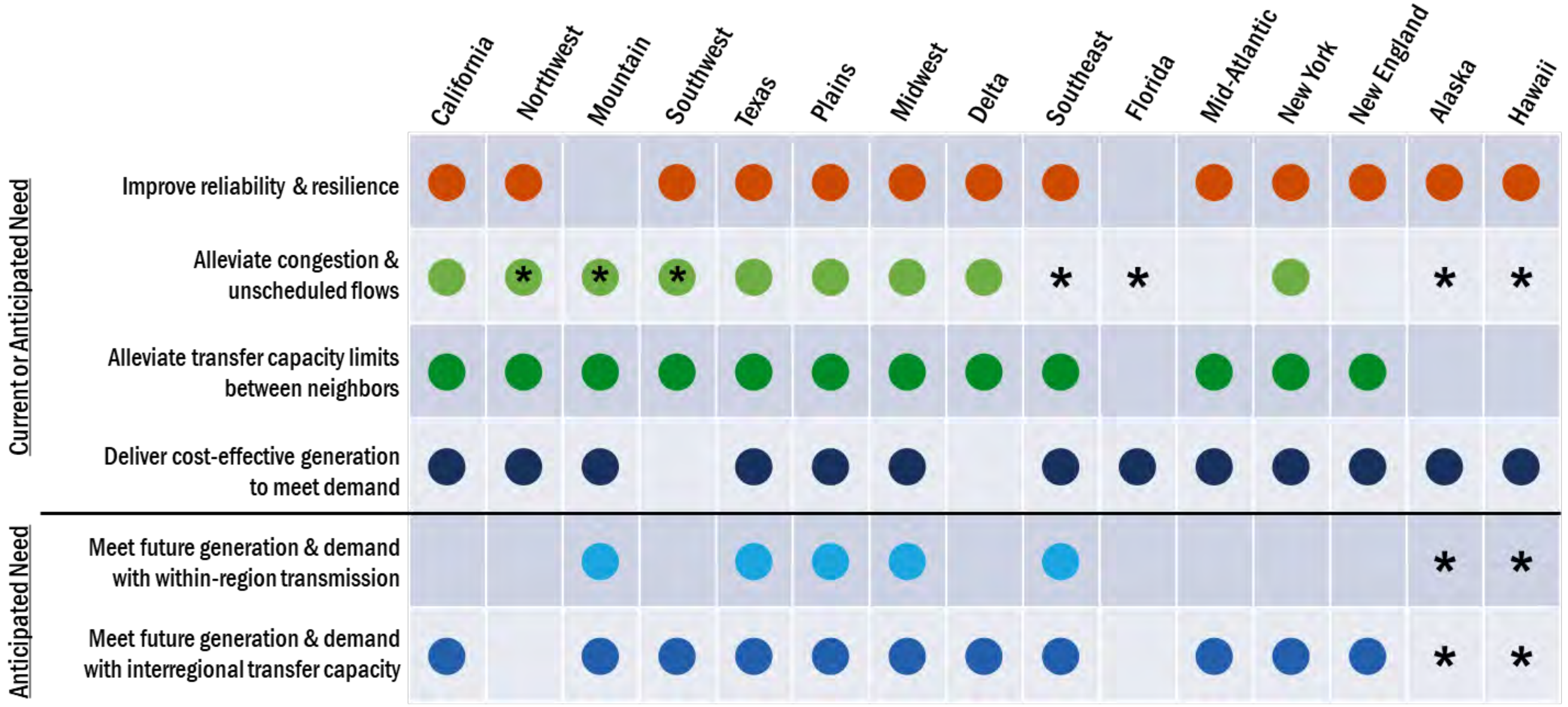
Geographic areas where a transmission need exists could benefit from an upgraded, uprated, or new transmission facility to…



* Wholesale market price data is limited for non-RTO/ISO regions and capacity expansion modeling data is limited for Alaska and Hawaii. Absence of data does not necessarily indicate that there is no need for new transmission.

And we find that over time, through the year 2040, that these needs increase significantly in nearly all regions, and are in need of interregional transmission.

Before we move on, we just wanted to quickly note a couple of things here. In instances where a circle-- or an indicator of need-- is not filled with any color, or appears white, the Department concludes that there is not sufficient evidence to suggest that a transmission need exists, or that there is an absence of data that does not allow for proper assessment of transmission need.

And then finally, you'll notice asterisks in two instances. The first being in the indicator of need corresponding to alleviate congestion and unscheduled flows, particularly in the non-RTO/ISO regions. So, the Northwest, the mountain region, Southwest, Southeast Florida, Alaska, and Hawaii. The reason being is that there is a limited wholesale market price data available in these regions, which is one of the data points that the Department has used to assess whether such a need exists. However, the Department may have found this need to exist using other resources, particularly those in the Section V literature review.

The second set of asterisks here are included underneath Hawaii and Alaska for their anticipated need buckets; to meet future demand within regional transmission, and interregional transfer capacity. The Department used capacity expansion modeling results to assess whether those needs exist across the country, and those capacity expansion models neither included Alaska nor Hawaii.

As we move on to the dashboard on this slide, you'll notice we provide the same set of data points here. Nothing has changed since the last slide. We just have a new format in the dashboard format here. This appears alongside each instance of the geographic map portion of that graphic. So again, we have region labeling up top, and then the high-level buckets of need on the left-hand side here.

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IV. Historical Data

IV.a. Historical Transmission Investments

IV.b. Market Price Differentials

IV.c. Qualified Paths

IV.d. Interconnection Queues

And with that, I will hand things over to my colleague, Dr. Adria Brooks. Thank you very much.

DR ADRIA BROOKS: Thank you, Jesse. So, Jesse went over all the important things. I'm just going to cover a lot of the details that are in the report that helps to support the decisions that were made in creating that summary graphic. But again, that's just a summary graphic. So, the details here do help explain a lot of our reasoning and a lot of the specific needs that we found throughout the nation.

As Jesse went over, there are seven chapters in the Needs Study. I'm just going to cover those last three chapters that really have detailed results.

I'm jumping in here at Chapter IV with historical data. This is broken into four different sections; historical transmission investments, market price differentials, qualified paths, and interconnection queues.

Because we have limited time, I'm only going to touch on a couple of things that are in this chapter. But do know there's a lot more information in the study itself.

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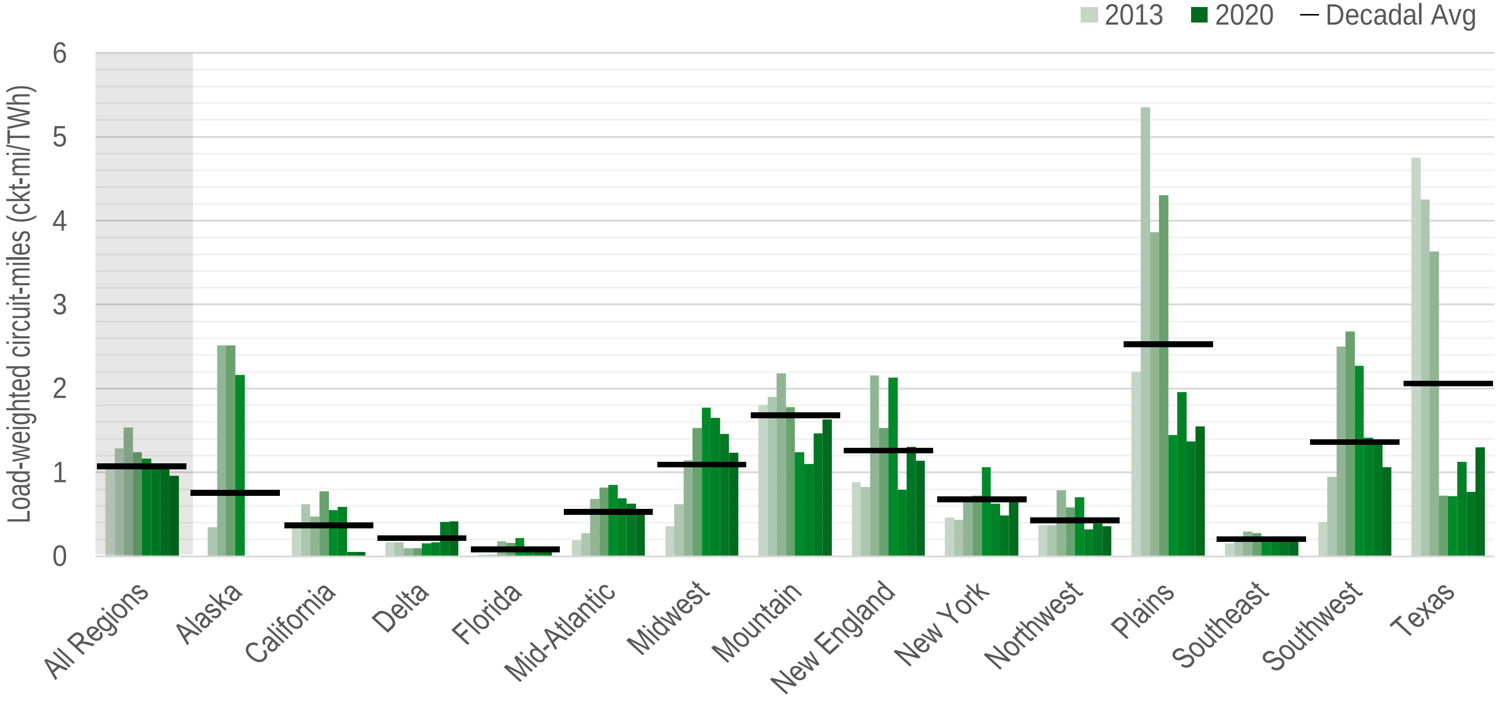
Transmission investments decreased during the second half of the 2010's.

Load-weighted circuit-miles of transmission by in-service year, 2011-2020

3-yr rolling averages plotted



Data from MAPSearch Transmission Database (2023). All transmission lines rated at or above 100kV.

Our very first finding of need in the Needs Study is that transmission investments decreased during the second half of the 2010's. Plotted on this chart are circuit miles of new investment every year that they were installed between 2011 and 2020 across different regions of the United States.

The leftmost cluster of bars show all regions of the entire United States, but then we also break it out by individual region. In general, you can see that there's this uptick in new transmission coming online between 2011 and 2015. And then that drops off over the latter half of the decade.

That's visible for all regions, but it is also visible across several individual regions. For example, in the mid-Atlantic, the Midwest, the Southwest, you can see this growth of new transmission being installed, and then that dropping off around middle of the decade.

I'll note that on this slide, we're showing circuit miles of new transmission installed weighted by load, which is why, for example, Alaska seems so high in comparison to the other regions. It's just because we're trying to understand an apples-to-apples comparison of how much load this transmission is trying to serve.

But in the study itself we also show just the absolute amount of circuit miles, and the capital costs that were spent on new transmission investments in all different regions.

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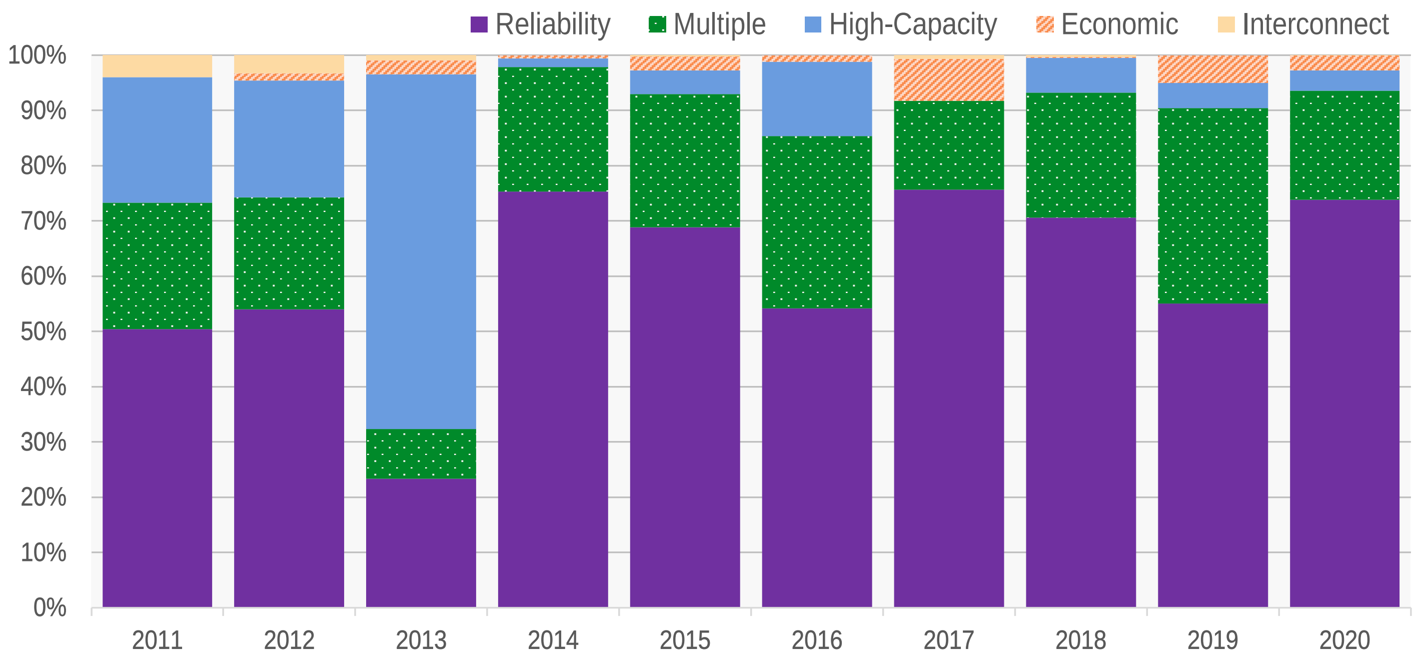
Incremental, local reliability needs were the primary driver of transmission investments in most regions.

Proportion of national circuit-miles installed each year by project driver



Data from MAPSearch Transmission Database (2023). All transmission lines rated at or above 100kV.

We can also look at why transmission was being installed over the last decade. Shown here is the percentage of all transmission investments by the primary driver. And this is, again, for the entire U.S. We did break this out by region in the final Needs Study, which is different from the public version. We were asked to do that during public comment.

But just to talk about the high-level National results here, we find the biggest driver of transmission investments were these incremental local reliability needs which are shown in purple. In 2011 about half of all transmission projects were to address reliability needs. And then in 2020, that goes up to 75%.

These local reliability needs, these are usually done at lower voltages. So, we're talking about smaller lines and shorter distances, about 161 kV or less. Those are just meant to address something that is local to a community. They are not meant to address reliability across the entire region or even inter-regional.

Another thing that jumps out from this is the data that's shown in blue. These are high-capacity lines, rated at 230 kV or above. These are really long transmission lines that are meant to move power from one region of the country to another. We see there was a lot of investment in high-capacity lines in 2011, 2012, 2013. And then that dropped off precipitously to where there's very few investments the rest of the decade.

And again, we do break this data out by region. We can talk in Q&A about which regions were really making those larger investments.

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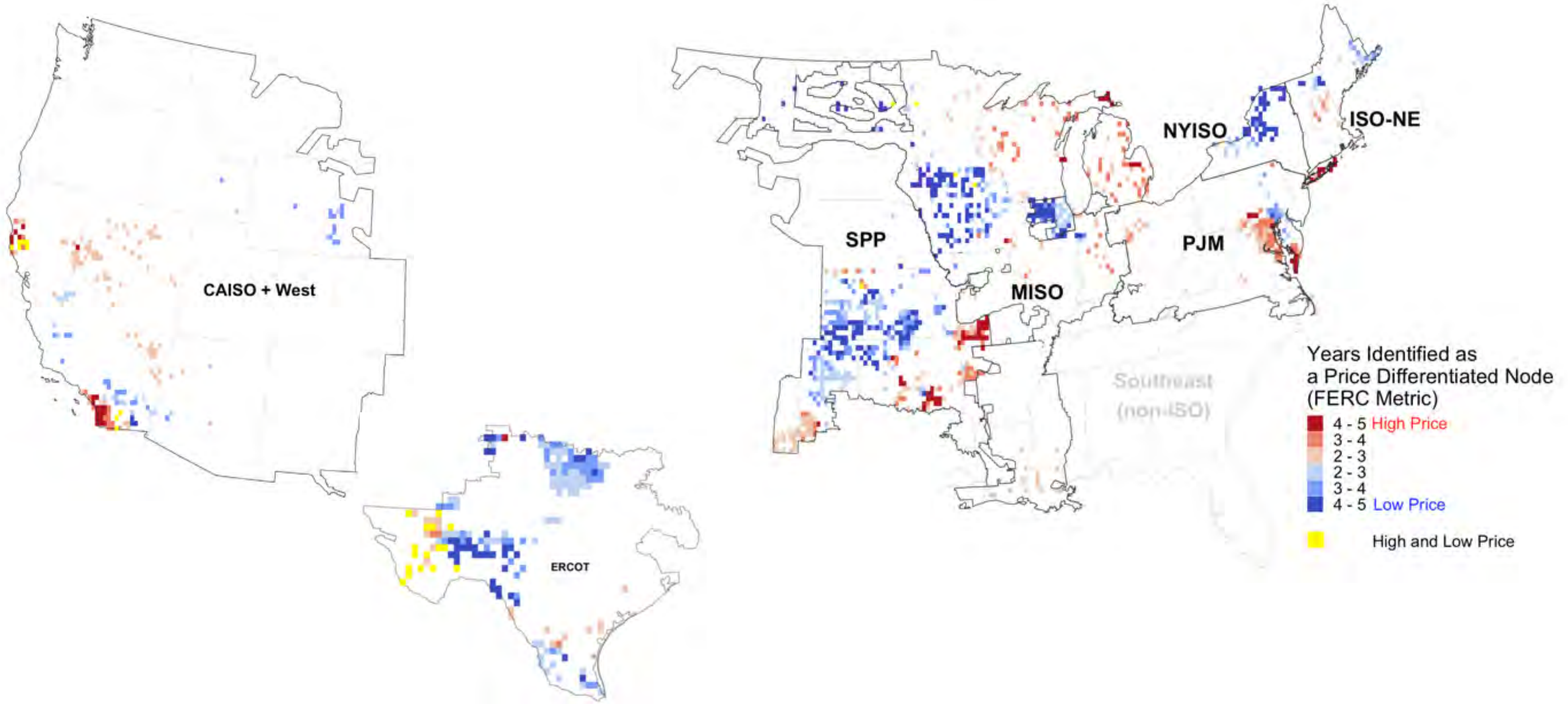
Regional price differences highlight locations of persistently high electricity prices.

The Market Price Differential metric helps identify opportunities for transmission, even when grouping all interconnect regions together.



Millstein, et al. Lawrence Berkeley National Lab (2022a)

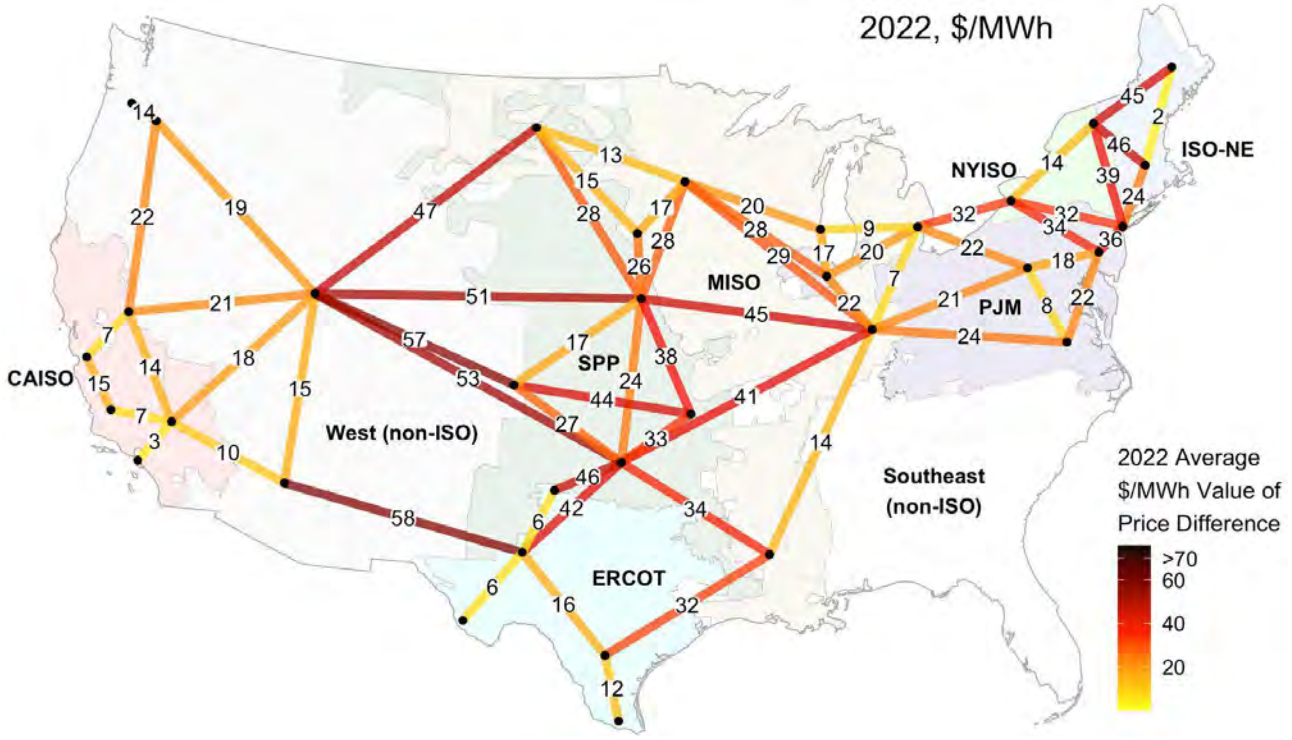
Switching now to a different type of analysis where we're looking at wholesale electricity prices-- so not the prices that you and I pay when we're paying our utility bills, but what our utilities pay for electricity. We can look at regional price differences to help highlight where there's persistently high prices for communities throughout the U.S.

So, this chart shows historic wholesale pricing data across the entire U.S. Anything that's in dark blue means that those prices were consistently lower than the median for that interconnection year after year. So those little blue dots throughout the country, that's where utilities are paying less than their neighbors for electricity; usually because there's access to low-cost generation in those areas.

On the opposite end, there are many areas in red where there are persistently high prices; where electricity is particularly high-priced in these locations. This can be an energy justice concern where communities are perhaps paying more for electricity than they would need to. Alleviating congestion by building more transmission would enable access lower cost generation and bring it into those areas.

Interregional price differences suggest large value in cross-interconnection transmission to alleviate harmful congestion.

Each link shows marginal value ($/MWh) of relieving congestion.
Trends are consistent dating back to 2012.



Millstein, et al. Lawrence Berkeley National Lab (2023)

This is looking at the same data, but just a different way to slice it. Here we're showing the differences in electricity prices between two nodes. So, these little black dots, these are hub prices. Take for example the node in Phoenix, Arizona. That's not really Phoenix. That's all of Arizona and New Mexico. We're trying to understand how does the price in that hub, in that area of the country, compare to whatever it's linked to?

And that gives us a sense of congestion, or where new transmission-- or upgraded transmission-- would really help to alleviate congestion on the power grid. So, in general, the darker the color of those links, or the higher the number, the more value there is in installing new power lines or upgrading existing power lines between those locations on the power grid.

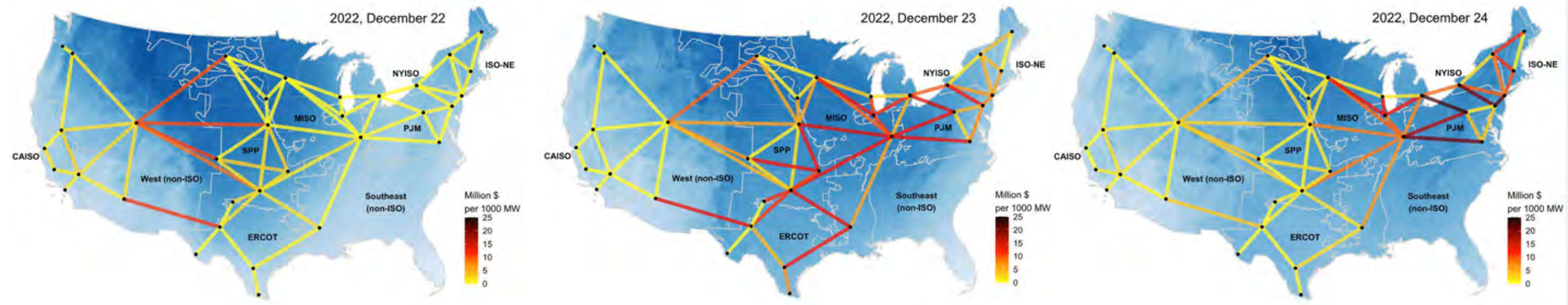
What jumps out immediately are the links between the West (non-ISO) and SPP, as it's labeled on the graph. These links are connecting the Western Interconnection and the Eastern Interconnection; two physically separate grids. Connecting across those interconnections would have huge value in alleviating congestion.

We also see very high valued links between ERCOT—so another physically separate grid—and the other two interconnections, the Eastern and Western Interconnections. Additional connections across these seams would help alleviate transmission congestion.

Looking within just the Eastern Interconnection—so from SPP all the way over to the Atlantic Ocean—we can also see high value connecting between SPP and MISO, and between New York and its neighbors-- particularly New York and ISO New England. A lot of value there in additional interregional transmission.

Highest transmission congestion is concentrated in only a few hours of the year and during extreme events.

High interregional price differentials traveled across the U.S. along with Winter Storm Elliot.



Millstein, et al. Lawrence Berkeley National Lab (2023)

If we do that same analysis but isolate extreme events, we can see that there's even more transmission congestion. Or, rather, that the highest amount of transmission congestion is really concentrated only a few hours of the year. Particularly during the extreme events that we've seen over the last several years.

What's on the chart now is just showing transmission congestion value during winter storm Elliott. It's a winter storm that hit at the end of last year around the Christmas holiday. You can see the exact same type of links, but instead of showing average prices over the course of an entire year, we're only looking at average prices over the course of the day.

The left-most map shows December 22 prices, then December 23, and December 24 on the right. That high value of transmission congestion where new links would really help benefit reliability or alleviate congestion on the power grid, we can see those shift. On December 22, we really see high value between the Western and the Eastern Interconnections. And then that moves across the country to December 24, where we see high vlaue up in New England and the mid-Atlantic region.

The blue color on the map, that is the surface temperature. So, the darker the blue, the colder it was. You can really see how the transmission value followed winter storm Elliott as it moved its way across the country over the course of those three days.

There's other analysis in the Needs Study that highlights this for other winter storms, not just Elliott. But it is insightful to see this movement day by day and to plot it out in this way.

V. Review of Existing Studies

- V.a. Reliability & Resilience
- V.b. Regional Congestion & Constraints
- V.c. Generation & Demand Changes
- V.d. Alternative Transmission Solutions
- V.e. Siting & Land Use Considerations

All right. So that's all I'm going to cover for Chapter IV. I'm going to move into the fifth chapter, Review of Existing Studies.

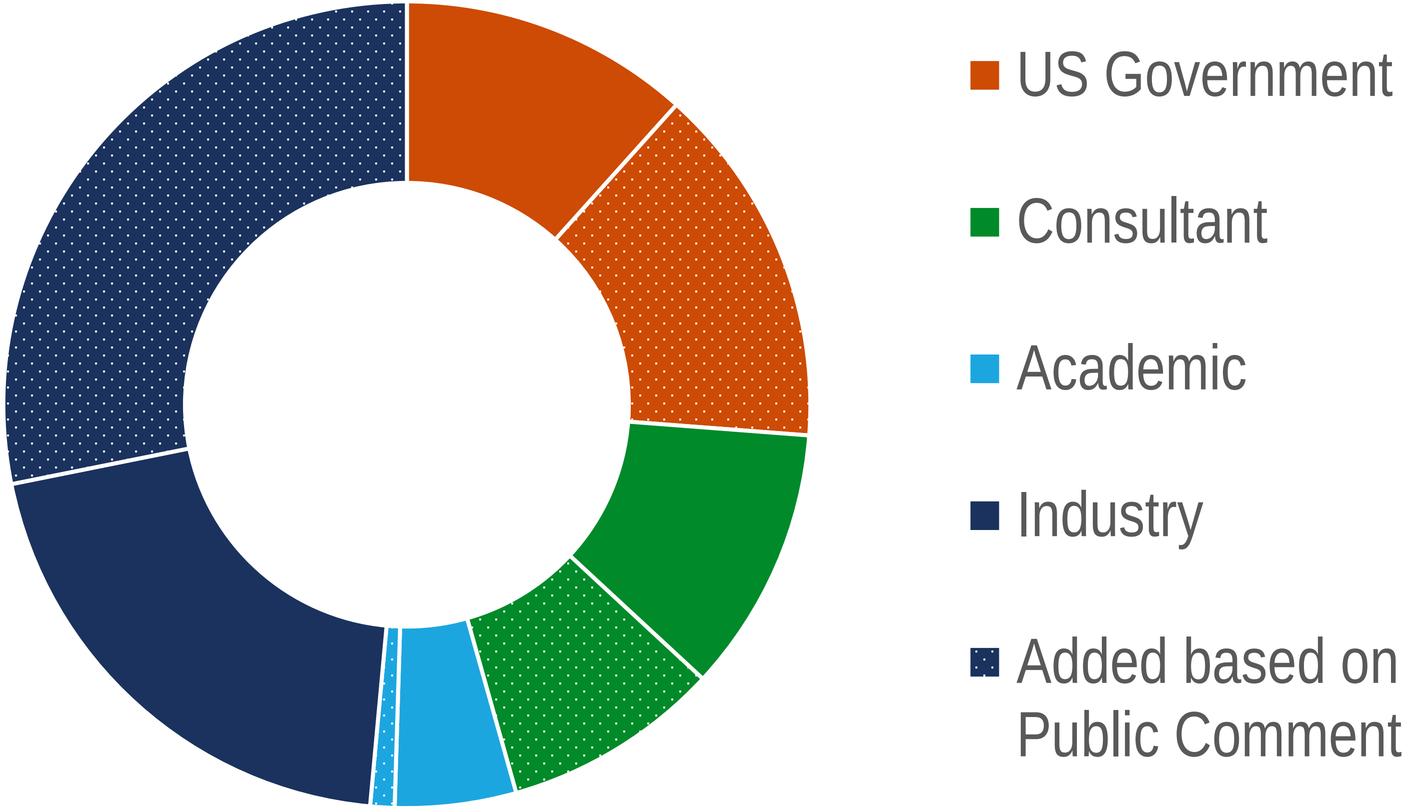
We had a lot of public comments on this section. A lot of folks suggested new studies to include, or new types of analysis that we should be looking at. We did heavily modify the study from the public version to accommodate those requests.

Now this chapter is organized into these five sections. First, we talk about reliability and resilience benefits of transmission and the needs in that area. This is followed by regional congestion and constraints, generation and demand changes, alternative transmission solutions, and then finally, we did add a subsection on siting and land use considerations based on public feedback.

I'm just going to highlight some high-level takeaways from each of these subsections without getting into a lot of detail. But I will talk about some level of detail just to give you an example of what's in the report.

GRID DEPLOYMENT OFFICE

100+ Transmission studies reviewed (2015-2023)



This is a snapshot of all the studies that were considered. There were over 120 studies that were reviewed just in this chapter alone. There's lots others that were in other sections of the report, but just here, over 120 studies dating back to 2015. And this chart gives a snapshot of who the study authors were.

In orange, we have U.S. Government reports. A lot of those are Department of Energy or National Lab reports, but also other U.S. agencies.

In green we have consultant reports, notably consultants who are active in the power sector space.

In light blue, just a thin slice there of academic reports that felt very relevant to include.

But over half-- or just at half-- of all the studies came from industry in dark blue. So, what are the transmission planners saying they need on the power grid? What is the Federal Energy Regulatory Commission saying? What is NERC saying?

Now to explain the differences between the solid colors and those speckled or dotted colors. The dotted colors are those that were added based on public comment. You can see we more than doubled all the studies that were considered in the previous draft, and they were pretty evenly distributed between the different study authors types.

V.a. Reliability and Resilience – Key Takeaways

- Transmission can support a reliable grid with high penetrations of **variable energy resource generation.**
- Transmission can mitigate impacts of **extreme weather events.**
- Increased grid connectivity can support **resource adequacy.**
- Interregional transmission across the **interconnection seams** can improve reliability and resilience.

I'm just going to highlight, again, the key takeaways in each subsection. So for reliability and resilience, we have—

Transmission can support a reliable grid with high penetrations of variable energy resource generation. Predominantly folks think of wind and solar in this category.

Transmission can mitigate impacts of extreme weather events. We already showed some of that when we looked at the historical data. But lots of other reports suggested the same.

Increased grid connectivity can support resource adequacy.

Interregional transmission across the interconnection seams, in particular, can improve reliability and resilience. And again, that's something that was shown from looking at the historical data as well.

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V.b. Regional Congestion and Constraints - Key Takeaways

- While historic transmission investments in **New England** have resulted in low congestion, future generation changes are expected to increase congestion in some areas.
- Largest transfer limitations within **New York** are between upstate and Long Island.
- Significant congestion and constraints exist in eastern, coastal **Mid-Atlantic.**
- Significant constraints and congestion exist between the **Midwest and Delta.**
- Congestion in the **Plains** is related to limited transmission capacity and high wind generation output.
- Constraints and congestion costs in the **West** are growing as the generation resource mix changes and demand grows.
- **Texas** anticipates major east-west in-state congestion as demand grows.
- **Alaska** has limited transmission transfer capacity between generation and major load centers.
- Isolated transmission systems in **Hawaii** are reaching capacity.

All right, to the next subsection; Regional Congestion and Constraints. A long list of takeaways here, specific to each region of the country--

First, while historical transmission investments in New England resulted in low congestion, future generation changes are expected to increase congestion in some areas.

The largest transfer limitations within New York are between upstate New York and then Long Island.

Significant congestion and constraints exist in the Eastern coastal areas of the mid-Atlantic.

Significant constraints and congestion exist between the Midwest and the Delta region, specifically.

Congestion in the Plains is related to limited transmission capacity and high wind generation output.

Constraints and congestion in the West are growing as generation resource mix changes and demand grows. A lot of demand growth in the West is really driving the congestion that we're seeing there.

Texas anticipates some major East/West congestion within state, specifically as demand grows.

Alaska has limited transmission transfer capability between generation and major load centers.

And then finally, isolated transmission systems in Hawaii are reaching their current capacity.

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V.c. Generation and Demand Changes – Key Takeaways

- New transmission will be needed to access many **clean energy resources.**
- **Reduced curtailment** of available economic generation resources can be achieved with additional transmission.
- Offshore wind potential is driving transmission needs, but **offshore transmission networks** require specific planning considerations to meet those needs.
- **Tribal lands** have unique energy and transmission needs.
- **Load growth** will require more transmission.

Next Generation Demand Changes—

New transmission will be needed to access many new clean energy resources to bring those online.

Reduced curtailment of available economic generation resources can be achieved with additional transmission.

Offshore wind potential is driving transmission needs, but offshore transmission networks require some very specific planning consideration in order to meet the needs. It's very unique compared to what we're doing on the terrestrial transmission system.

Importantly, tribal lands have unique energy and transmission needs. And I'm going to dive into a little bit of extra data there in a moment.

And then finally, load growth will require more transmission.

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Tribal lands have unique energy and transmission needs.

Jones, et al. DOE Office of Indian Energy (2022)

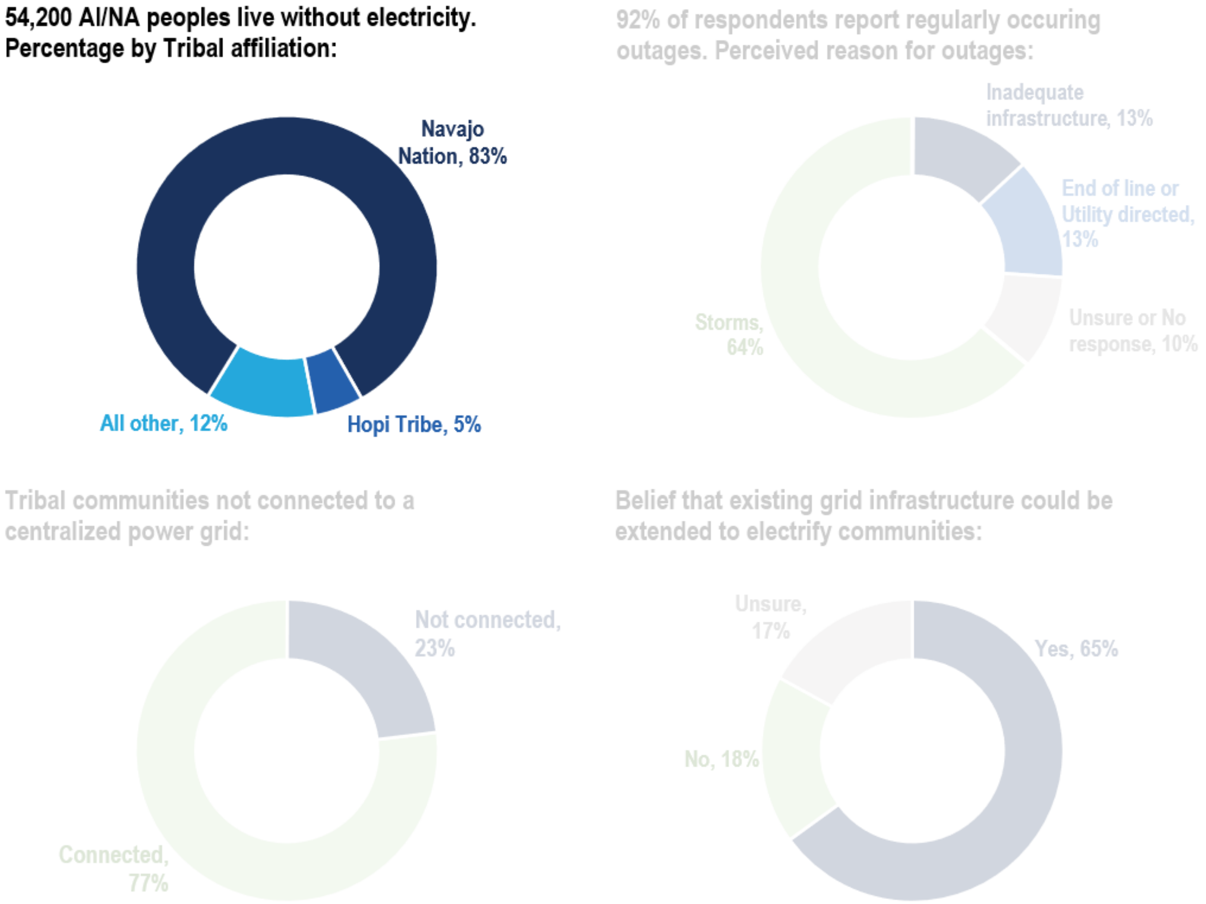
On the point of tribal lands have unique energy and transmission needs, we were asked to try to include more updated data about tribal needs during public comment. So, we worked with the Office of Indian Energy at the Department of Energy to gain access to some survey data that they're in the process of taking and analyzing.

I'll just quickly highlight a couple of things that came out of that analysis. But do recognize that the Office of Indian Energy is going to publish a more formal report in the coming years.

This is survey data of tribal nations across the United States. And all the respondents are those from the tribes themselves. These aren't responses from the utility companies or from the transmission providers that service those communities. They are from the communities.

GRID DEPLOYMENT OFFICE

Tribal lands have unique energy and transmission needs.



Jones, et al. DOE Office of Indian Energy (2022)

Over 54,000 American Indian / Native Alaskan peoples do live without electricity today. Their percentage by tribal affiliation is shown here in this donut chart.

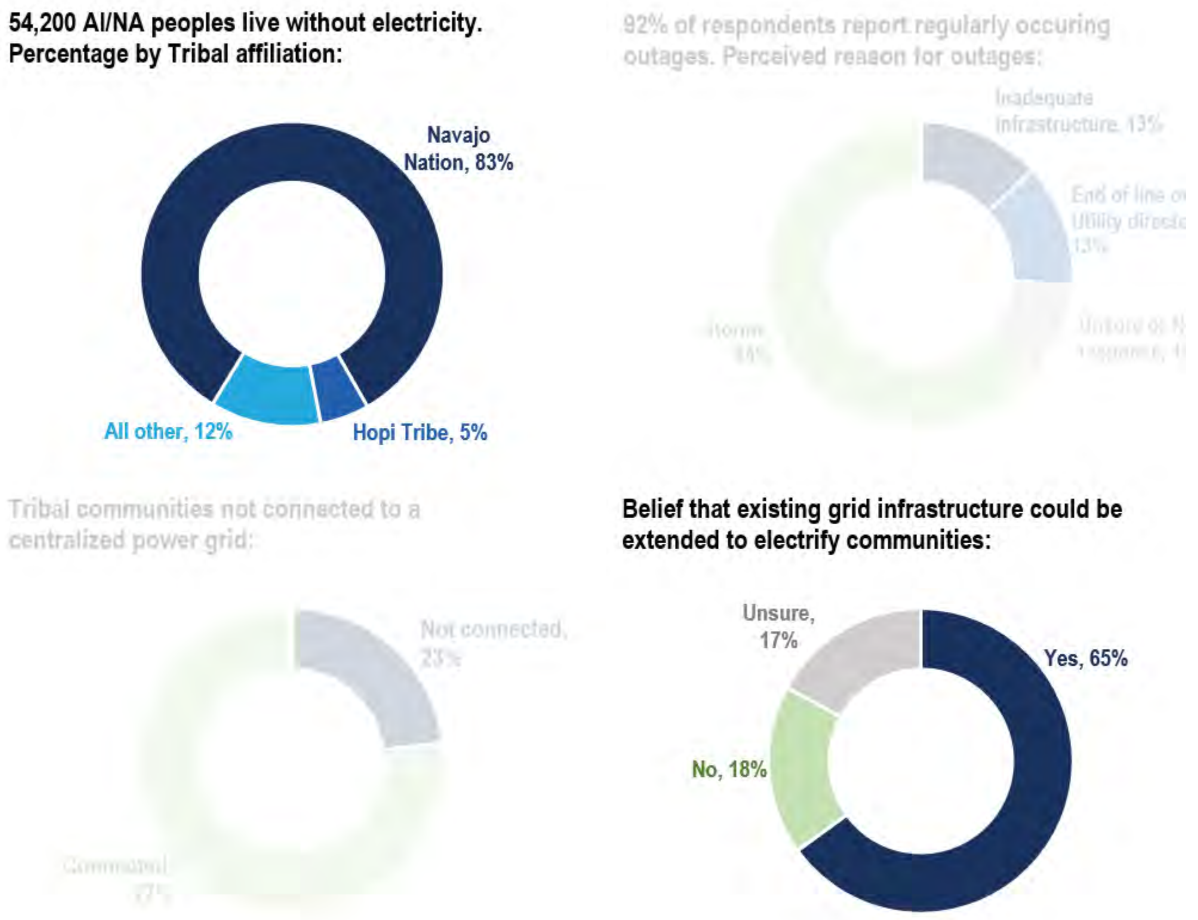
Over 80% of that 54,000 are on the Navajo Nation specifically. Another 5% are in the Hopi tribe, and then all others-- so just over 10%-- are of other tribal affiliations.

While a lack of electricity is felt by tribal peoples across the U.S., there is certainly a locational aspect here.

The Navajo Nation and the Hopi tribe, geographically, are in the Four Corners region of Arizona. They're co-located tribal nations. Lack of electricity acces is something that is specific to their region in many ways.

GRID DEPLOYMENT OFFICE

Tribal lands have unique energy and transmission needs.



Jones, et al. DOE Office of Indian Energy (2022)

And then finally, of all the folks who were surveyed, there's a belief among tribal communities that the existing grid infrastructure could be expanded to help electrify their communities.

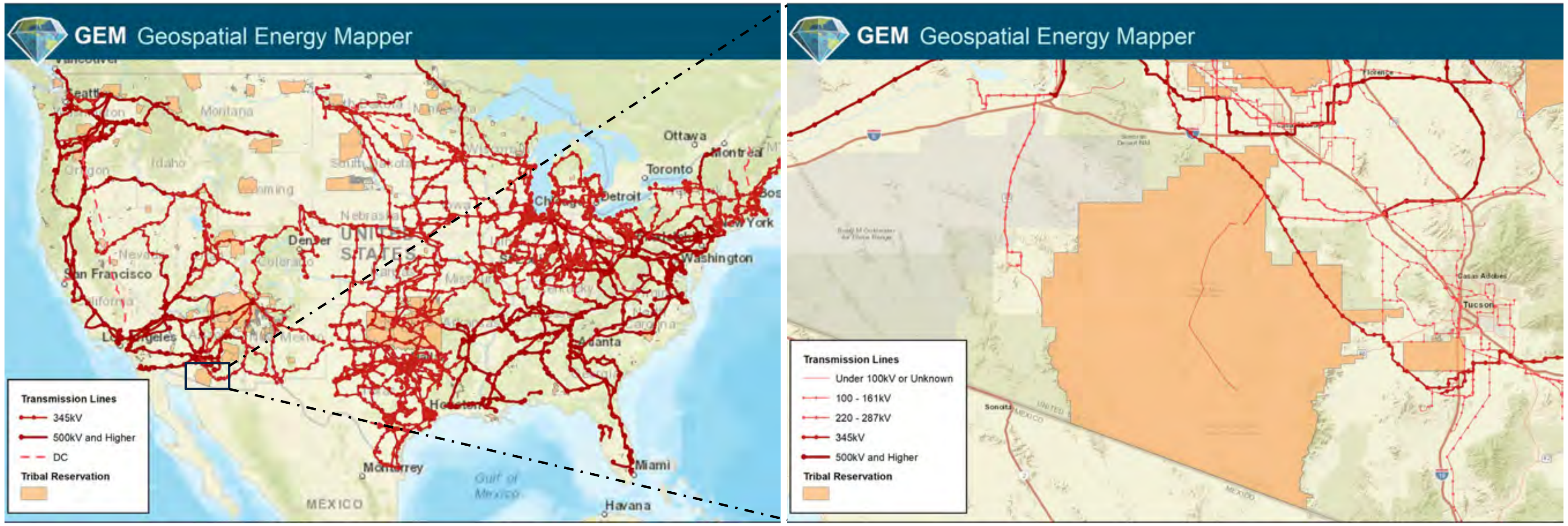
Over 65% of those who were surveyed said yes, if we were to expand the grid infrastructure into their communities, they would have either access to electricity or more reliable access to electricity.

And then about 20% said no.

Another 20% were unsure.

GRID DEPLOYMENT OFFICE

Transmission access limited on some tribal lands and prevalent on others. DOE tools can help visualize overlap.



Kuiper, J. Argonne National Lab (2022)

And then just to highlight the overlap between the transmission system and tribal nations, there are several DOE tools that can help visualize this. And just taking a quick snapshot it becomes obvious that transmission access is limited on some tribal lands, whereas it's more prevalent on others.

This is a snapshot taken from the geospatial energy mapper, which is a GIS tool available online. If you Google it, you will find it and can start playing with it. It has many different layers of the power sector that can be plotted.

What's shown here is the overlap between the transmission system and tribal nations. You can see all tribal nations-- at least Federally recognized tribes-- in orange, and then the transmission system in red plotted on top. The breakout on the right is a zoom in of a Tohono O'odham Nation in Southern Arizona.

And you can see that there is some access to the transmission system on those lands, but it's certainly not prevalent across the entire tribal nation. So if the Tohono O'odham wanted to develop different generation sources, this might be a tool to help understand access to the transmission system. This is useful for other folks who are looking to have a bird's eye view of the system, and where there might be issues needing to run new transmission lines in order to develop generation.

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V.e. Alternative Transmission Solutions - Key Takeaways

- **Energy storage** can aid the transmission system by balancing generation and load.
- High penetrations of **distributed energy resources** can shift regional transmission needs.
- **Grid-enhancing technologies** can improve the operational efficiency of existing transmission systems.
- **Advanced conductors and cables** can increase transmission transfer capacity.
- **Microgrids** can bolster the resilience of the transmission system.

Moving on to the next subsection, Alternative Transmission Solutions. There were some changes that were made to this subsection based on public feedback –

First, energy storage can aid the transmission system by balancing generation and load.

High penetrations of distributed energy resources can shift regional transmission needs.

Grid-enhancing technologies can improve the operational efficiency of existing transmission systems.

Advanced conductors and cables can increase transmission transfer capacity.

And, finally, microgrids can bolster the resilience of the transmission system.

V.e. Siting and Land Use Considerations - Key Takeaways

- **Siting** transmission can be a major challenge.
- **Co-location** of transmission corridors is possible in some cases.
- Transmission siting must balance **competing land use interests.**
- Community, stakeholder, and Tribal **engagement is imperative.**

Then the last section of Chapter V, the Siting and Land Use Considerations. Again, this was heavily changed based on public feedback –

Siting transmission can be a major challenge.

Co-location of transmission corridors is possible in some cases, and I'll dive into a little bit of the data there.

Transmission siting must balance competing land use interests.

Community stakeholder and tribal engagement is imperative.

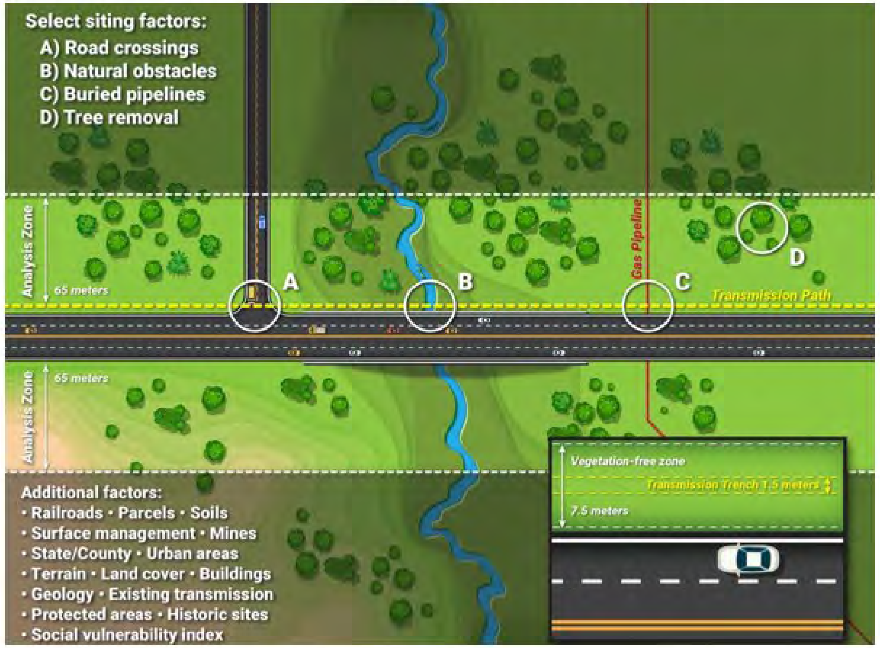
We will get into a little more detail on the co-location of transmission corridors, showing analysis that was done at the National Renewable Energy Laboratory. This analysis was previously unpublished, so we worked with them to publish it in the final version of the Needs Study.

GRID DEPLOYMENT OFFICE

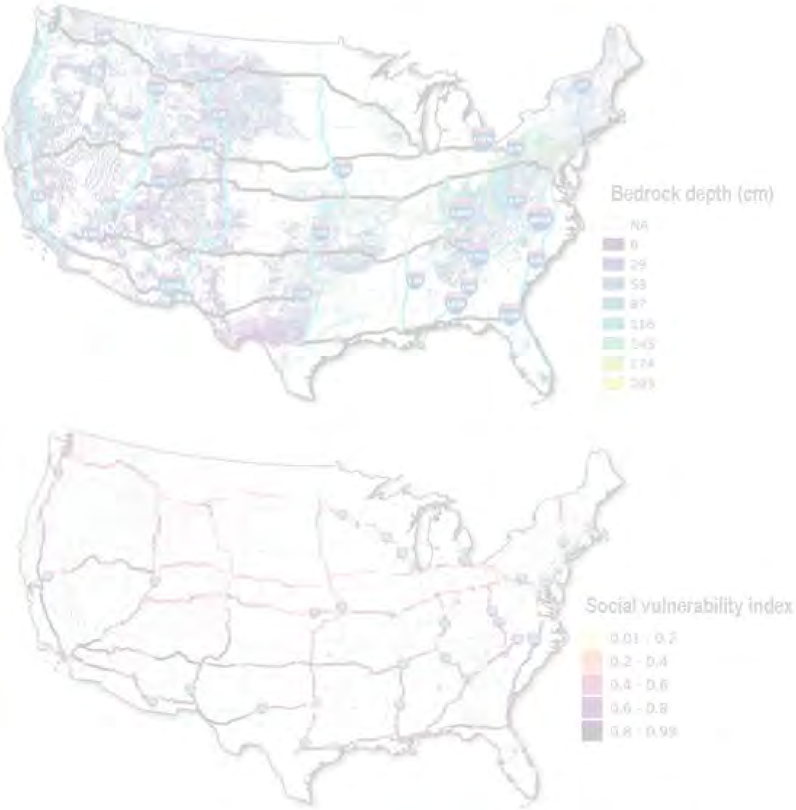
The first 10 miles of the McNary-John Day Transmission Line
Highway 14 in Washingtgon
Bonneville Power Administration

Co-location of transmission corridors is possible in some cases.

Analysis of buried HVDC along interstate highways



Lopez, A. National Renewable Energy Lab (2023)



This analysis considers burying HVDC transmission lines along interstate highways.

Highlighted here is an illustrative example of an interstate highway in the middle of the chart, and that yellow dotted line is the transmission path. To actually bury transmission within the existing interstate right of way, the analysis considers a 65-meter swath from the end of the interstate out into the neighboring area needed for construction.

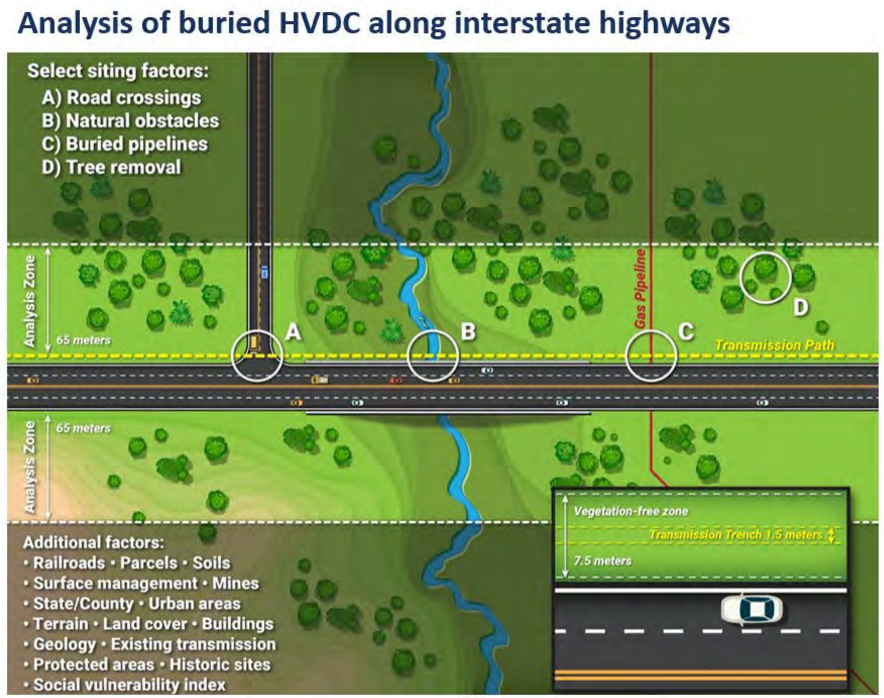
That 65-meters needed to bury HVDC would compete with whatever land use is already along the highway, whether it's a community or just open land. Now a lot of that swathe could be returned to its current use after burial, but nonetheless, the 65-meter swath is what was considered here.

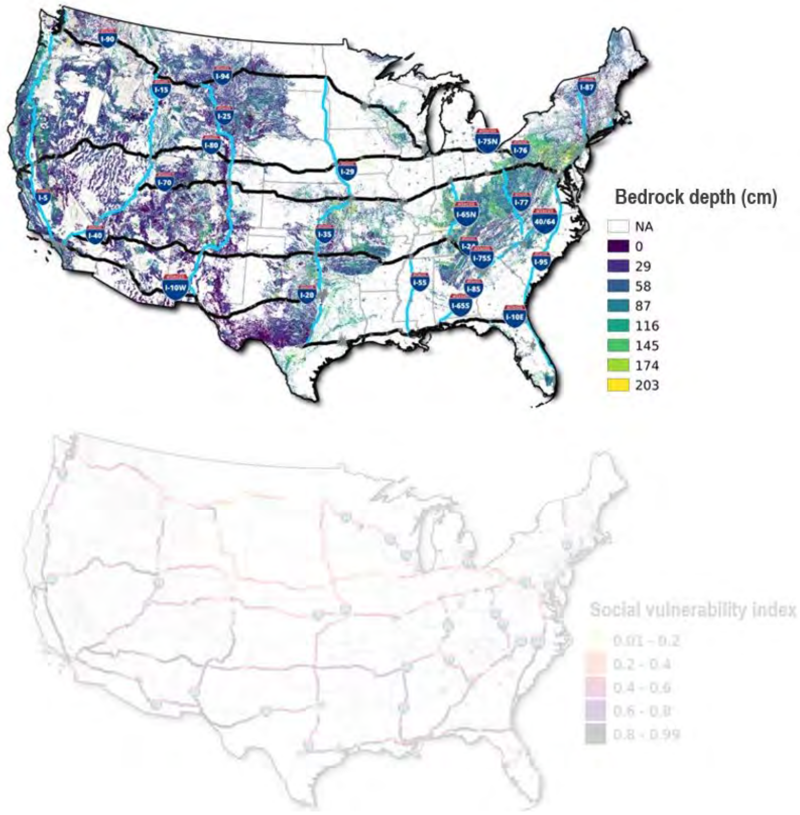
There are many different siting factors considered in this analysis. Obviously, I mentioned communities. So where do communities live along the interstates and how close to the interstates? But also, how many road crossings? All the on ramps and off ramps of the interstate, those have to be considered too.

Natural obstacles like rivers or creeks, buried pipelines-- lots of gas infrastructure crosses the interstates– must be considered. And then of course vegetation management or tree removal would need to be done in order to bury lines.

GRID DEPLOYMENT OFFICE

Co-location of transmission corridors is possible in some cases.





Lopez, A. National Renewable Energy Lab (2023)

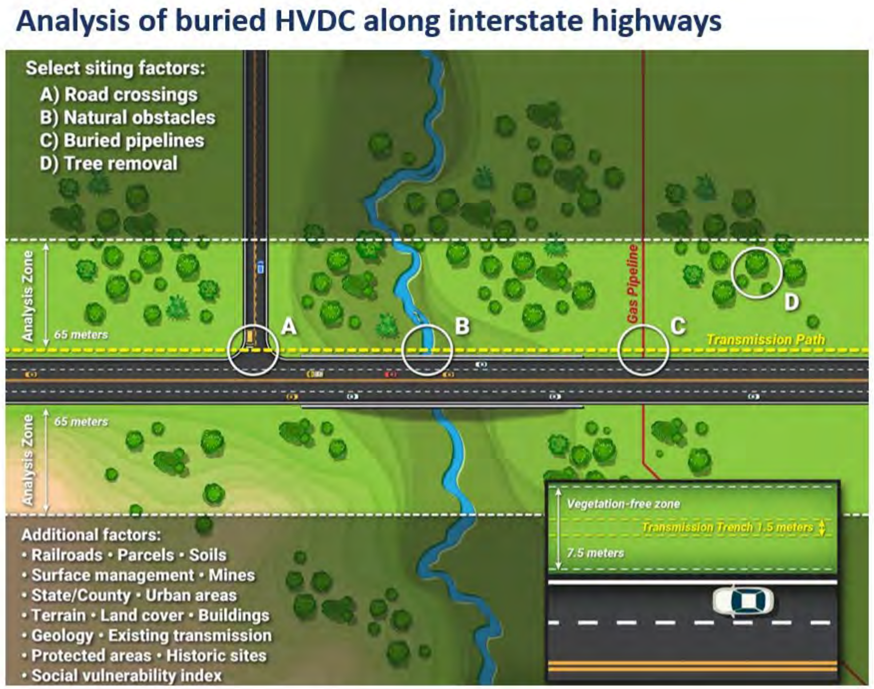
These maps are just examples of the types of things that we're considered in this analysis to understand how many of those different obstacles might a transmission line cross when burying transmission across the interstates. I'll just highlight a couple examples.

In the upper right, what is highlighted here is the bedrock depth. When burying HVDC lines, you're going to have to dig into the soil. The shallowness of the bedrock can make burying cost-prohibitive. If the bedrock is sitting at the surface, then it may be impossible to really dig into that in order to install a buried power line.

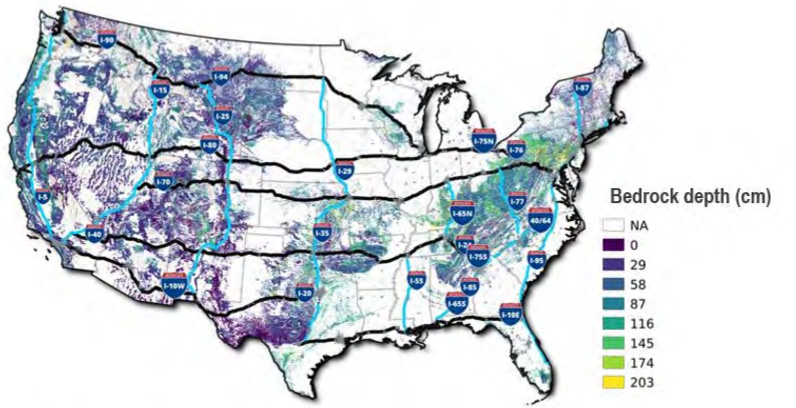
This chart is an analysis of where the most shallow bedrock depth is located. Any place where it's a dark purple means that it's pretty close to the surface and it may be impossible to bury there. Obviously, regions like the Rocky Mountains or the Appalachian Mountains is where you would expect there to be pretty shallow bedrock depth. But there is also shallow bedrock in some other regions of the country where maybe we don't expect it—like the middle of the country--just because there aren't mountains. These are some areas that might be tricky as well.

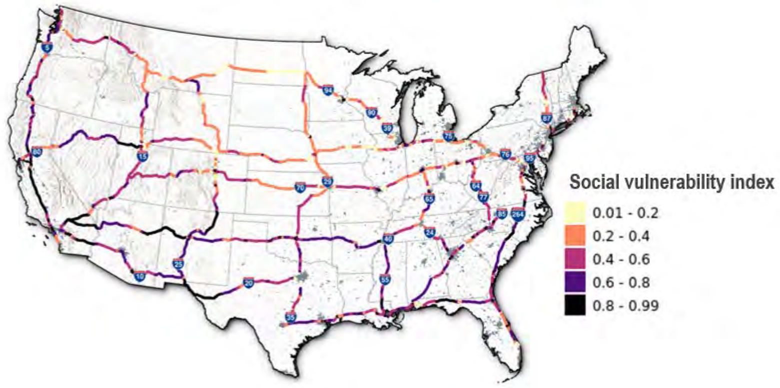
GRID DEPLOYMENT OFFICE

Co-location of transmission corridors is possible in some cases.



Lopez, A. National Renewable Energy Lab (2023)





Another example of factors considered in this analysis is the Social Vulnerability Index. This is an index developed by the Centers for Disease Control to understand cumulative burden on communities.

What are the different environmental factors that impact different communities across the United States?

The mapping shown here analyzes where those communities that are the most vulnerable to environmental impacts are located and how close are they to the different interstates. Do they live within that adjacent 65-meter swath along the interstates?

Here we have the color coding along the interstate highways themselves. The darkest colors mean that those are interstates that are running through communities that already have high cumulative burden. Consideration of how adding buried HVDC along interstates may further impact those communities should be taken. The lighter colors are where there are communities that have less social vulnerability.

These two factors are just examples. There's a lot more in the report that covers this analysis, but I did want to give a highlight of this since it is brand new from the public version.

GRID DEPLOYMENT OFFICE

VI. Capacity Expansion Modeling

VI.a. Included Studies and Scenarios

VI.b. Treatment of Alternative Transmission Solutions

VI.c. Within Region Transmission Deployment

VI.d. Interregional Transfer Capacity

VI.e. Comparison with Utility Plans

OK, I'm going to move into the final chapter, and then we'll open up for Q&A. The last chapter considers capacity expansion modeling.

This is really how the Department is trying to get an understanding of what is the future transmission need. We have to make assumptions about how the power sector is going to evolve into the future to understand future need.

This Chapter is laid out as follows—

First by showing included studies and scenarios.

A treatment of alternative transmission solutions within the capacity expansion modeling. And again, that's something that we were asked to add from the public.

Within region transmission deployment.

Inter-regional transfer capacity.

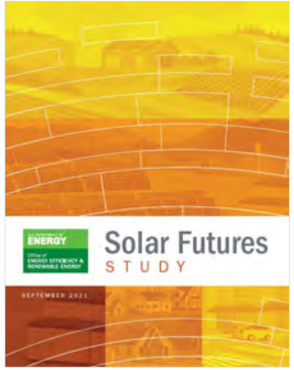
And then finally, we did a comparison of what these results suggest we need against what utilities are currently planning to do, how much transmission they're currently planning to install. So, we do a little bit of a comparison there with utility plans.

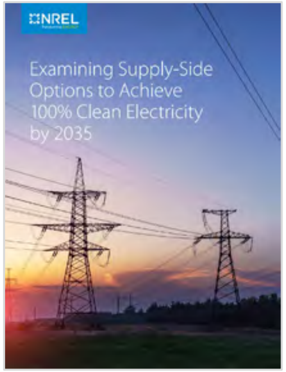
I'm only going to highlight a few things, of course, but happy to take questions.

GDO GRID DEPLOYMENT OFFICE

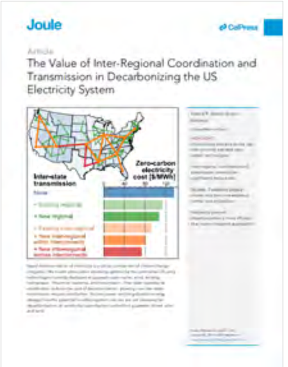
Data from 6 capacity expansion studies are analyzed to identify future regional and interregional transmission needs.

National Lab Reports





Academic Reports



Capacity expansion models optimize for least cost power sector solutions nation-wide given a range of input assumptions.

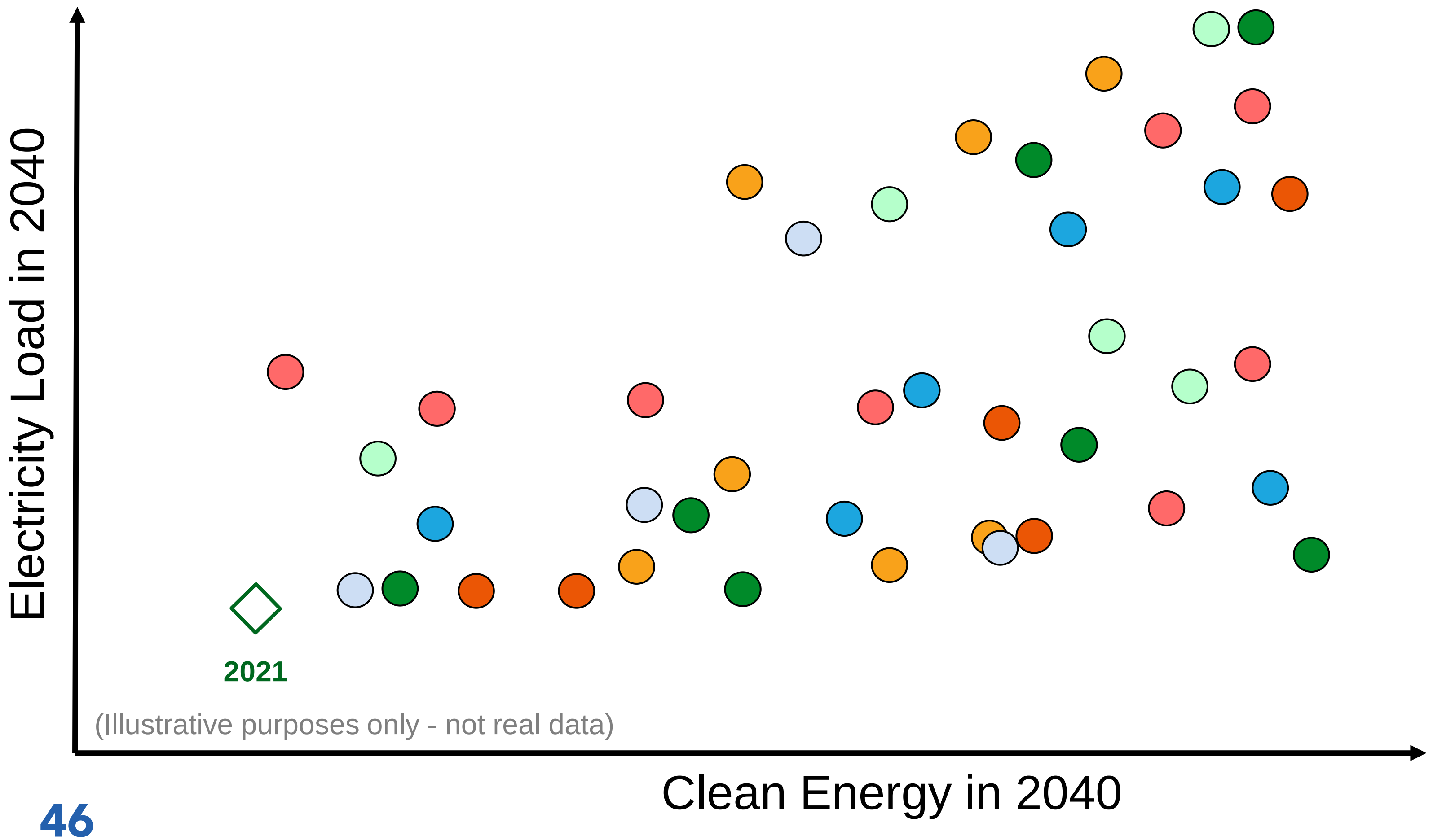
Model results help identify quantities of cost-effective transmission solutions and are used here as a proxy for future need to meet generation and demand growth.

First, we look at data from six different capacity expansion studies. We use those to identify future regional and interregional transmission needs. Four of those studies came from the National Renewable Energy Laboratory, and then two from academia; the "Net Zero America Project" from Princeton and the "Value of Interregional Coordination" that came out of research from MIT a few years ago.

There are over 300 scenarios included in all six of these studies. All the scenarios describe a very wide range of the future power sector. So, we needed a way to try to slice and dice this to make sense of what the transmission results were telling us. We did that by looking at the underlying study scenarios.

GRID DEPLOYMENT OFFICE

Need a way to group different scenarios in order to understand results: Looked to underlying scenario characteristics.



So plotted here-- this is just for illustrative purposes. I will show the real data later, but just to help us get a sense of what's going on.

Every dot here represents an individual scenario, and it's color-coded based on what study it came from in this example.

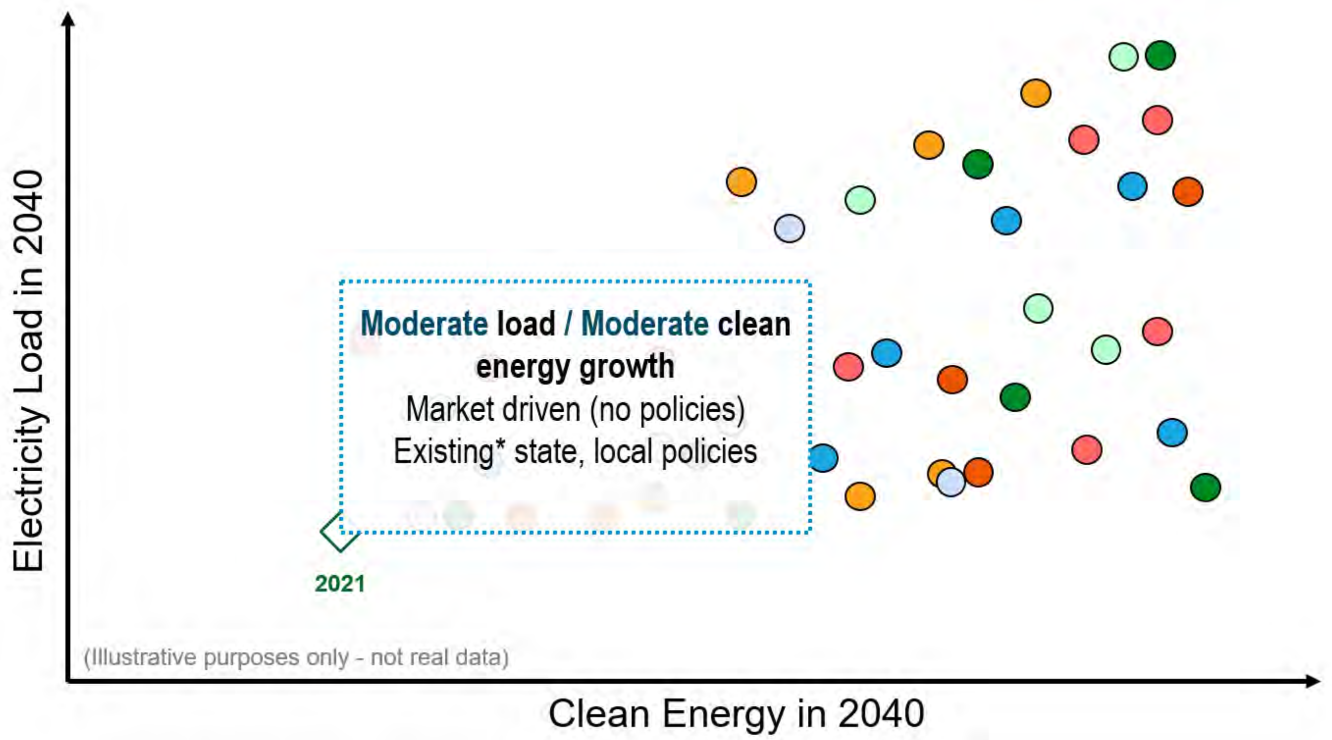
We want to understand the electricity load growth in 2040 compared to today. So, what is the amount of load that is going to be needed in the future? The amount of electricity demand that is going to be needed in the future is going to heavily drive how much transmission we're going to need.

Similarly, the amount of clean energy that we're going to have on the grid in 2040 also heavily drives how much new transmission is going to be needed. I'll just make a quick note here that by *clean energy*, in the Department's usage, is very expansive. So of course, there's wind, solar, hydropower, but this term also includes nuclear. This also includes gas or coal, so long as it's equipped with carbon capture and sequestration technologies. Landfill gas is included in here as well. So, this is a very expansive view of clean energy.

The diamond here shows the 2021 load and 2021 clean energy penetration for comparison. So, anything to the right of that diamond means clean energy growth. Anything above it means electricity load growth.

GRID DEPLOYMENT OFFICE

Need a way to group different scenarios in order to understand results: Looked to underlying scenario characteristics.



**Existing* at time of research, all pre-Inflation Reduction Act (IRA)

We broke these scenarios into three different scenario groups. First, we have moderate load and moderate clean energy growth.

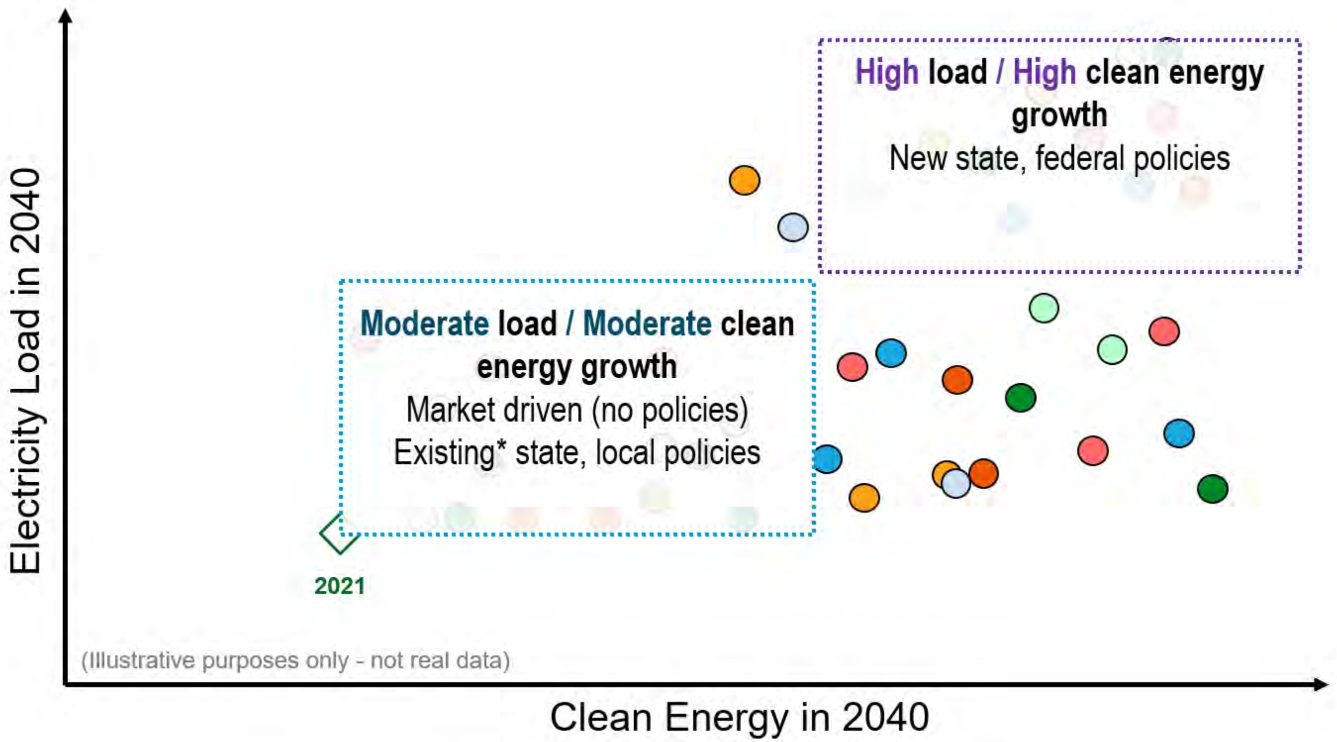
All the scenarios that fell within this category assume only a little bit of growth in either parameter (electricity load and clean energy) out to 2040.

Of the scenarios that fit into this scenario group, there were market driven scenarios, in which the researchers just ignored all state, federal, local policies in the modeling. So, for example, state renewable portfolio standards were taken out of the model, and they just allow markets to drive the future of the power sector.

There were also scenarios that included all existing state, local, and federal policies which existed at the time that the research was done. All six studies were done at slightly different times, so they might have slightly different policies that were considered.

GRID DEPLOYMENT OFFICE

Need a way to group different scenarios in order to understand results: Looked to underlying scenario characteristics.



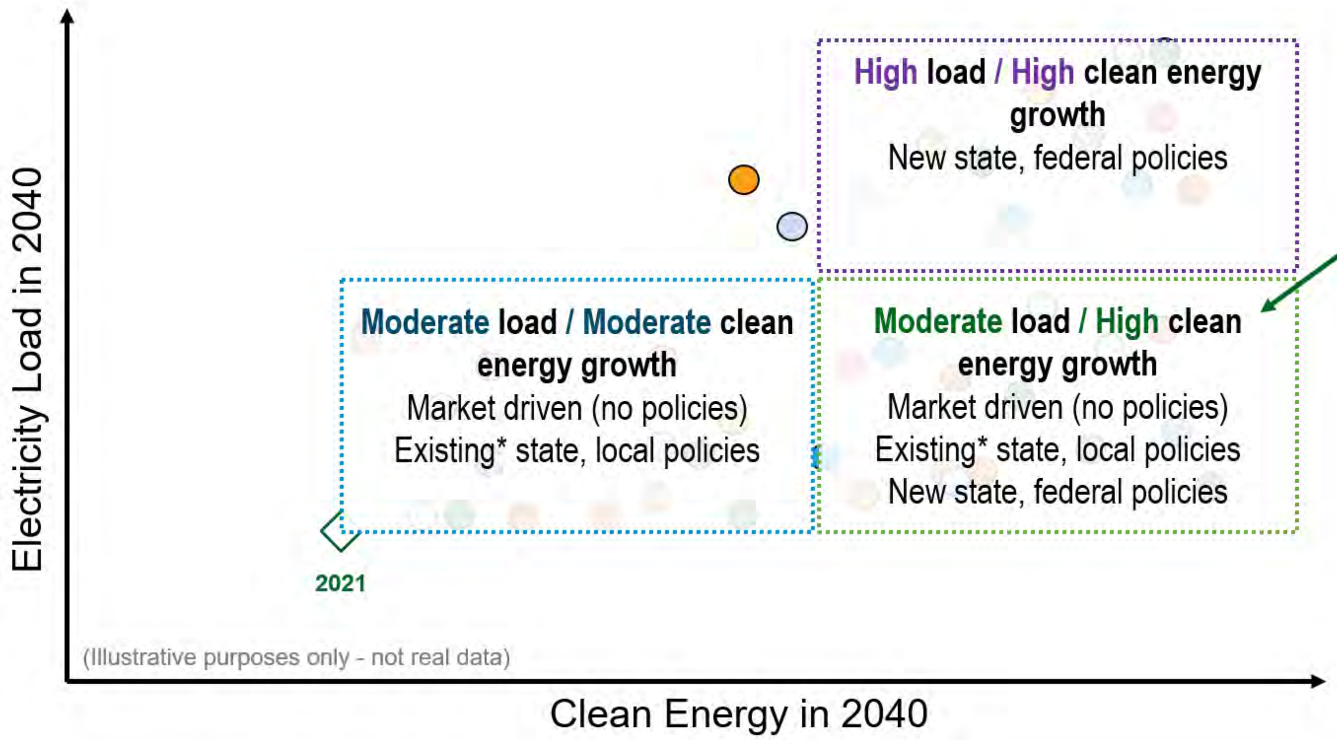
**Existing* at time of research, all pre-Inflation Reduction Act (IRA)

On the opposite end, we have scenarios that assumed high load and high clean energy growth.

Now, none of the scenarios that exemplify this high of load growth would happen under current policy conditions. So all the scenarios that fell into this group assume new state or federal policies were put into place in order to really push load growth as high as this.

GRID DEPLOYMENT OFFICE

Need a way to group different scenarios in order to understand results: Looked to underlying scenario characteristics.



Impacts of IRA: Modeling by several different organizations indicate that IRA will push the **new normal** into the **Moderate/High** scenario group.

**Existing* at time of research, all pre-Inflation Reduction Act (IRA)

And then finally, we have the moderate load, but high clean energy growth scenarios.

There's a whole range of different scenarios that were included here.

There were market driven scenarios; again, ignoring all policies.

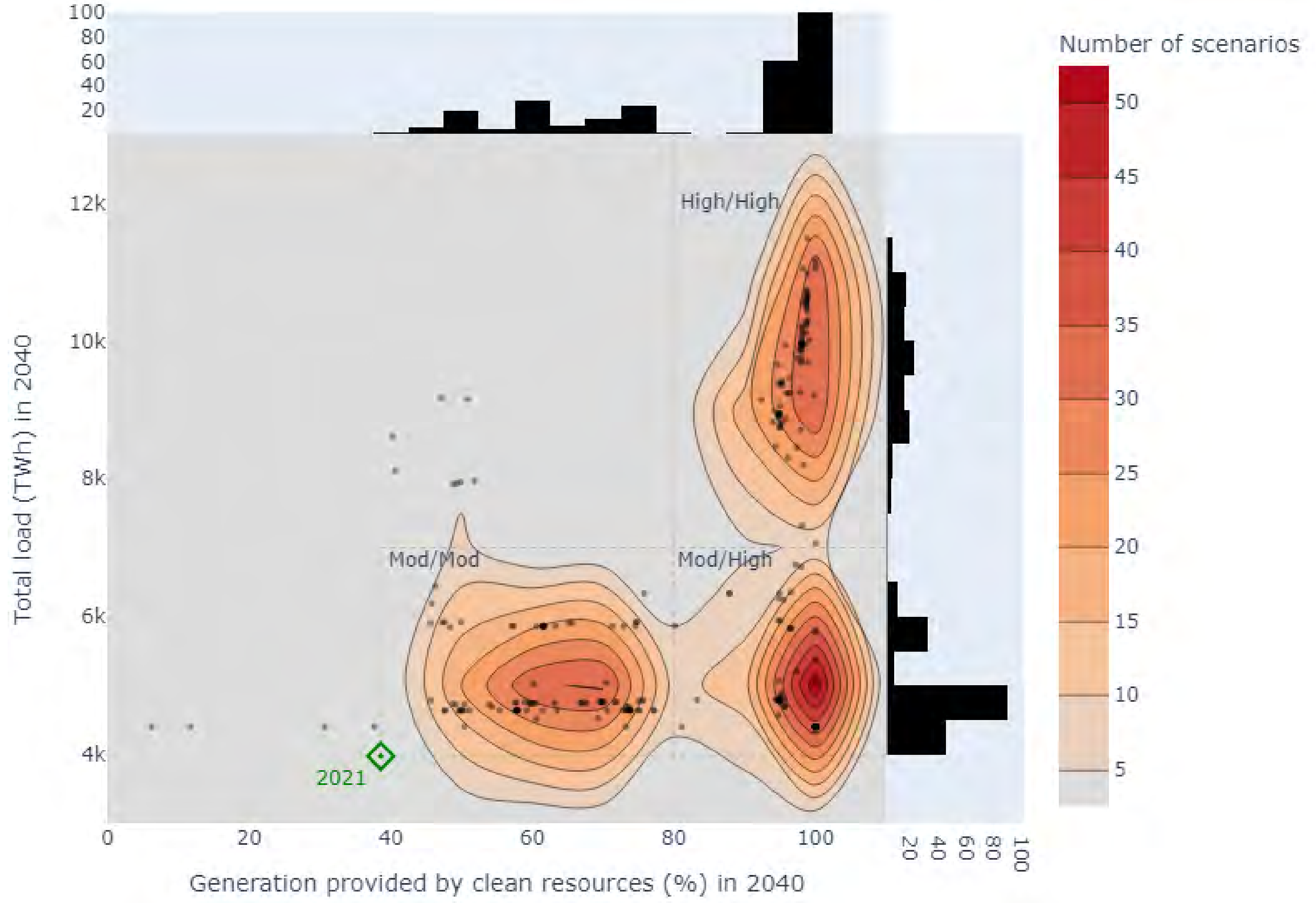
There were also scenarios which included the existing state, local, federal policies at the time the research was done.

A finally, scenarios which assumed new state or new federal policies were going to come online were also into this group.

I want to note that all six of these studies were done before the Inflation Reduction Act was passed. Updated research since the Inflation Reduction Act was passed shows that the future power sector is most likely to fall into this moderate load, high clean energy group. Of course, we do not know exactly where the 2040 power sector going to fall -- we have to make some assumptions -- but it's likely going to be somewhere within the bounds of this group given the addition of the Inflation Reduction Act.

So, we're considering this moderate load, high clean energy growth scenario group to be our new normal. Previously that moderate/moderate group might have been the business-as-usual group. But now we're looking to plan for the future given the moderate/high scenario category.

Natural grouping of all scenarios based on power sector characteristics



And I promised real data, so for the other data energy nerds, here is the data of all the scenarios-- all 300 scenarios-- that came from the six studies. Each of those black dots is a scenario. They're not color coded based on study in this chart; they're just all shown together. But you can really see now how these three natural groupings popped out when we look at the distribution of where the scenarios fell on these two parameter axes.

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300 scenarios across 6 studies considered

All scenarios broken into three groups and transmission results analyzed for three different years.

	Moderate / Moderate	Moderate / High	High / High
2030	2030 Moderate / Moderate	2030 Moderate / High	2030 High / High
2035	2035 Moderate / Moderate	2035 Moderate / High	2035 High / High
2040	2040 Moderate / Moderate	2040 Moderate / High	2040 High / High

OK, so just to recap, there's 300 scenarios across the six studies. We broke those into three groups. So, the moderate/moderate, moderate/high, and high/high scenario groups across the top of this chart.

We also analyzed the data for three different years: 2030, 2035, and 2040.

We have transmission capacity results for all nine of these different categories in the Needs Study itself. This allows readers to consider different years and types of policy scenarios when trying to understand the transmission results.

300 scenarios across 6 studies considered

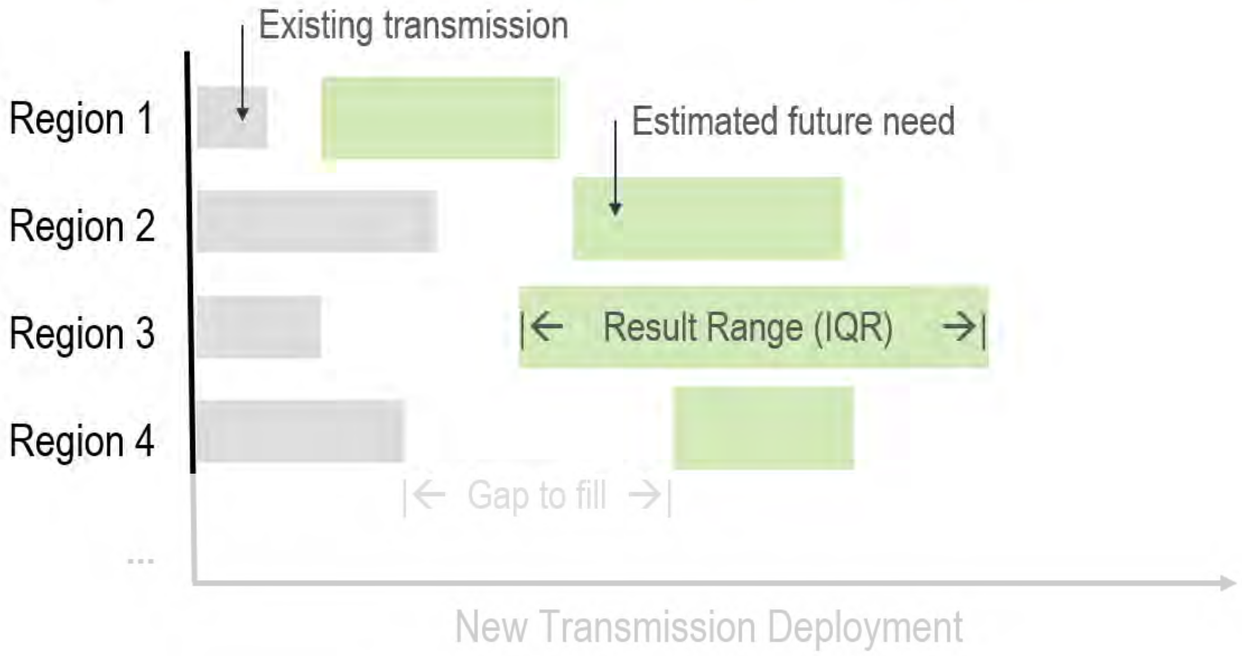
All scenarios broken into <u>three</u> groups and transmission results analyzed for <u>three</u> different years.

	Moderate / Moderate	Moderate / High	High / High
2030	2030 Moderate / Moderate	2030 Moderate / High	2030 High / High
2035	2035 Moderate / Moderate	2035 Moderate / High ★	2035 High / High
2040	2040 Moderate / Moderate	2040 Moderate / High	2040 High / High

Today, I'm just going to focus on 2035 results. And I'm mostly going to focus on our new normal, this moderate/high scenario group. But again, recognize that there are results from all nine in the study.

Quick tutorial on how to interpret transmission growth results

Make up of the future power system is unknown, so range of study results are presented.



And now just a quick tutorial on what you're going to see on the next slide.

In gray, we have the existing transmission system across all different regions of the U.S.

And then in green-- or it'll show up as different colors, but mostly green-- that's the estimated future need. We show a range of need because, of course, we don't know exactly what the power sector is going to be in the future. But we want to get an understanding of how much transmission is likely going to be needed to meet these different scenarios. We show a range for that reason.

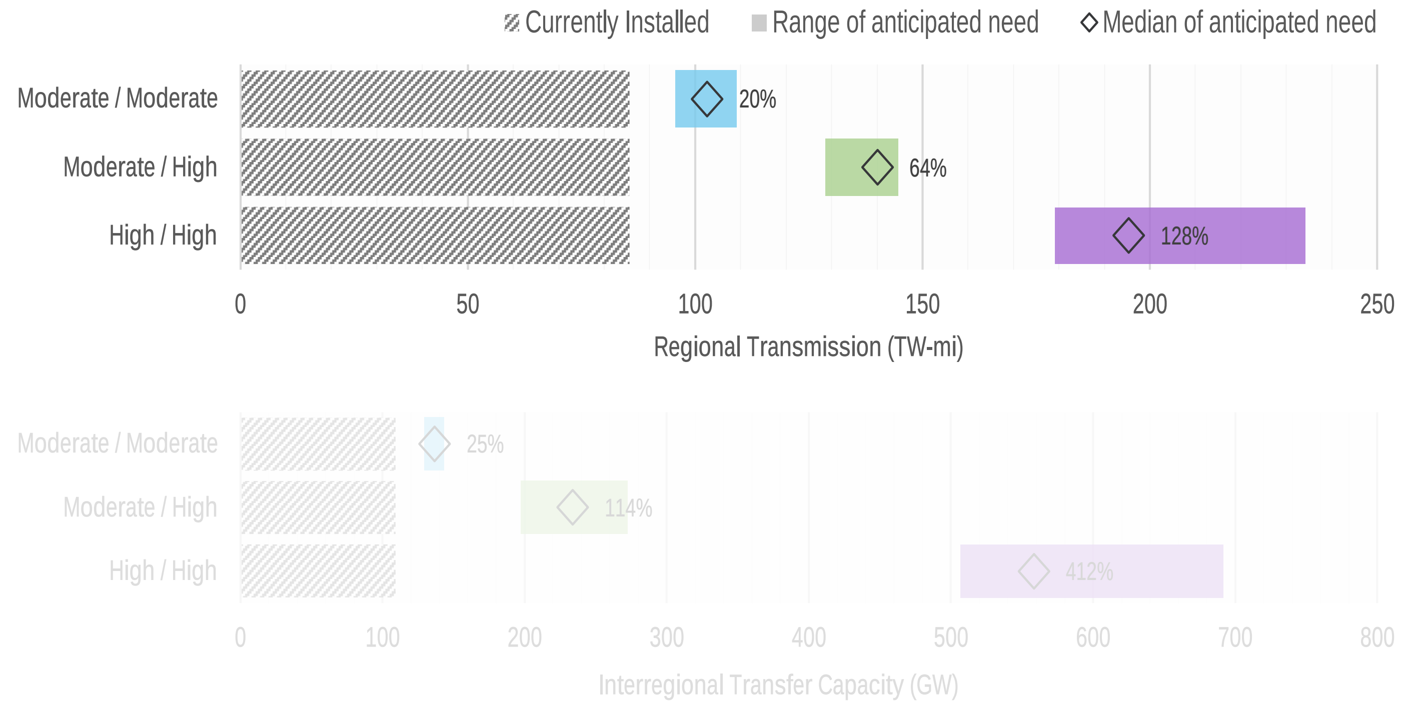
Importantly, though, is the gap to fill; how much do we need to build between what we have today and this estimated future need? How much needs to be built over the next several years to meet these future scenarios?

Increase in transmission deployment is needed in most future scenarios, especially given high clean energy and demand growth.

Within-region transmission and interregional transfer capacity need across the United States in 2035

Anticipated need for three future scenario groups labeled as __ load / __ clean energy growth.

Median percent growth compared to 2020 system shown.



Here are the results for the nation. Or at least for the contiguous U.S.-- not Alaska and Hawaii, but for the contiguous US. We find an increase in transmission deployment is needed in most future scenarios, especially given high clean energy and high demand growth.

So again, what's being shown here-- these gray hatched areas, this is the currently installed transmission across the three different scenario groups: moderate/moderate, moderate/high, and high/high. You can see the range of anticipated need out to the right in the different colors.

The diamonds are just the median of those ranges.

So, if we look at the moderate/moderate group-- our old business as usual case-- we can see at the median, we need about a 20% increase in transmission deployment nationwide compared to where we are today.

If we go out to our new normal-- so moderate load growth, but high clean energy growth-- we can see we need about a 60% increase in the transmission we have today.

And that need for more transmission is extended even further when we start talking about high load growth-- or high demand for electricity-- to where we need almost a doubling of the current system in order to meet those high load growth scenarios.

Now this top chart, this is just the within region transmission, not the inter-regional transmission.

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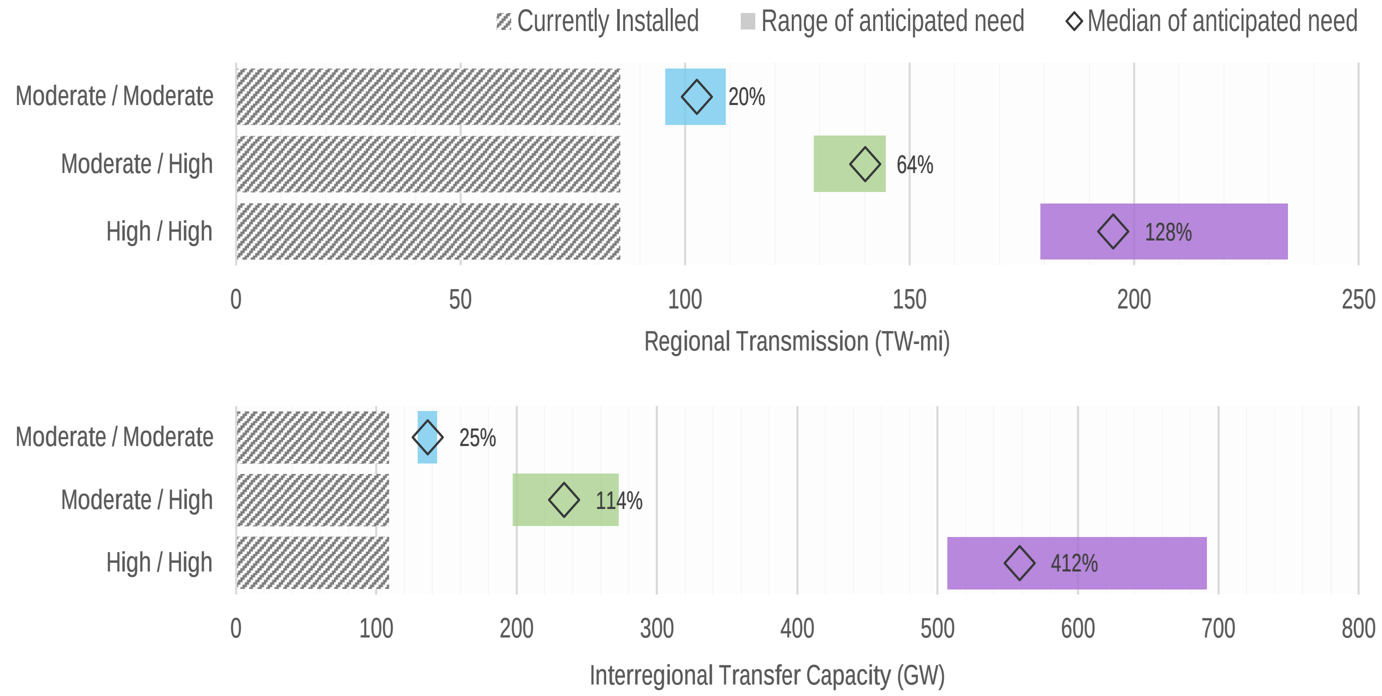
Increase in transmission deployment is needed in most future scenarios, especially given high clean energy and demand growth.

Within-region transmission and interregional transfer capacity need across the United States in 2035

Anticipated need for three future scenario groups labeled as __ load / __ clean energy growth.
Median percent growth compared to 2020 system shown.



If we break out the interregional transmission that's needed across the U.S., we get different results.

For the moderate/moderate scenario group, we see about a 25% growth is going to be needed by 2035.

In our new normal scenario group we see almost a doubling of the existing interregional transmission.

And then this result, of course, just grows exponentially when we talk about high demand growth. A 400% increase in interregional transfer capacity is the median result. So we need to really increase the amount of interregional sharing among transmission in order to meet these high demand futures.

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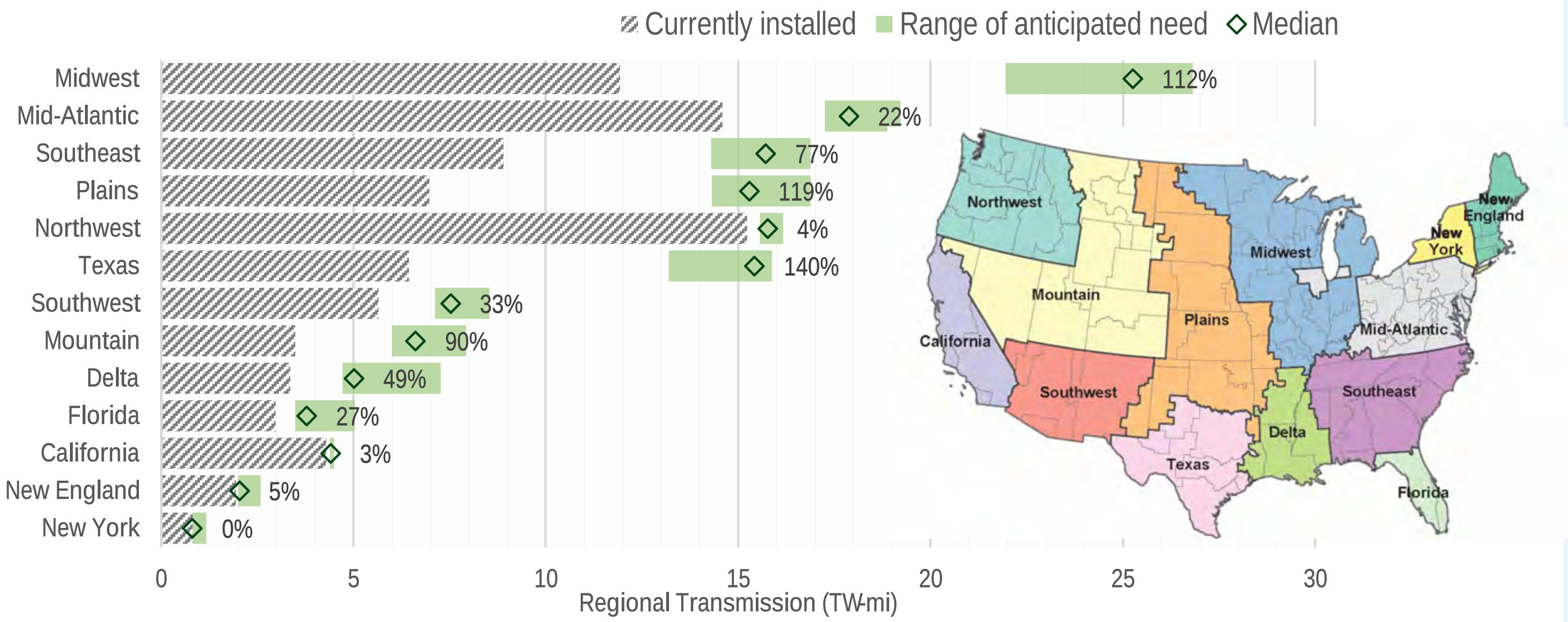
Regional Transmission Expansion Results (2035 Mod/High)

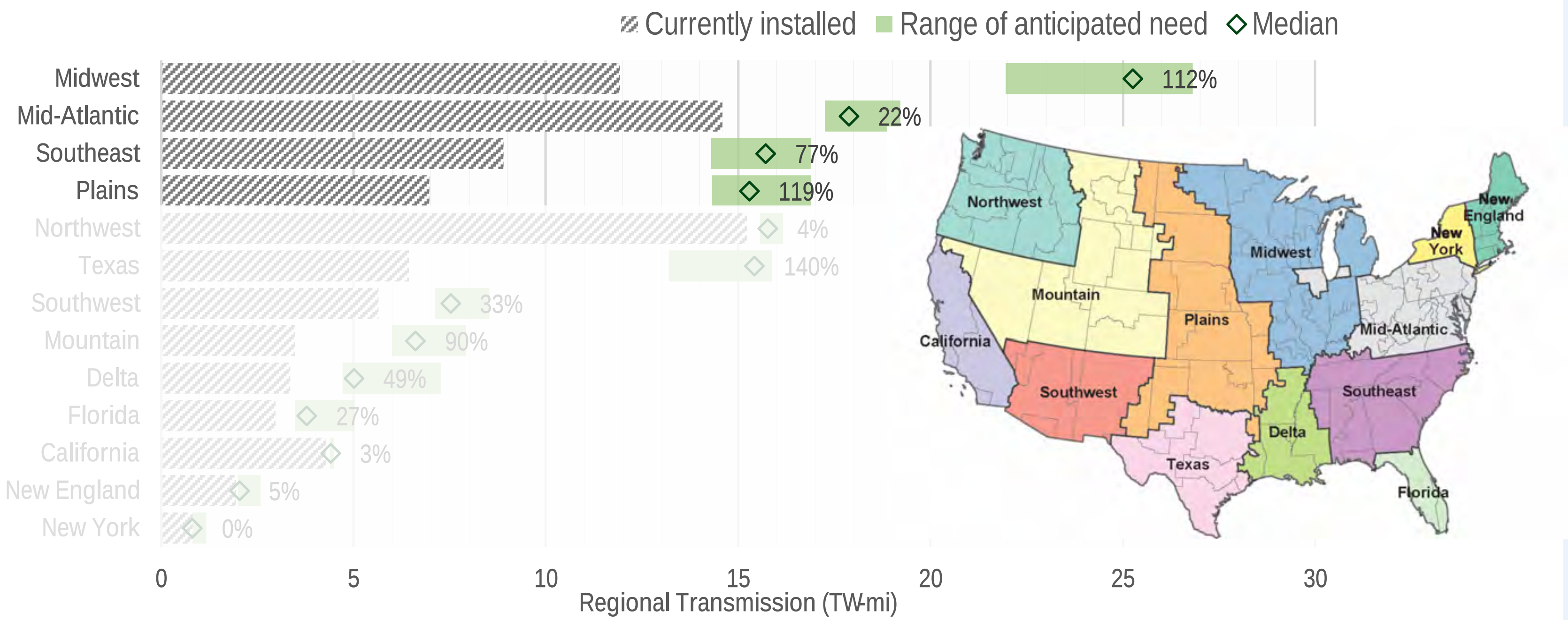


Results of scenarios which enable a 2040 power system:

- 80% - 100% clean energy deployment
- 25% - 75% load growth
- Power sector decarbonization

We do break these results out by the 13 regions in the contiguous U.S. as shown here. Just to level set, these are shown for the 2035 results for, again, our new normal, that moderate/high category. And then in descending order based on the total amount of final transmission need in 2035.

Regional Transmission Expansion Results (2035 Mod/High)



Results of scenarios which enable a 2040 power system:

- 80% - 100% clean energy deployment
- 25% - 75% load growth
- Power sector decarbonization

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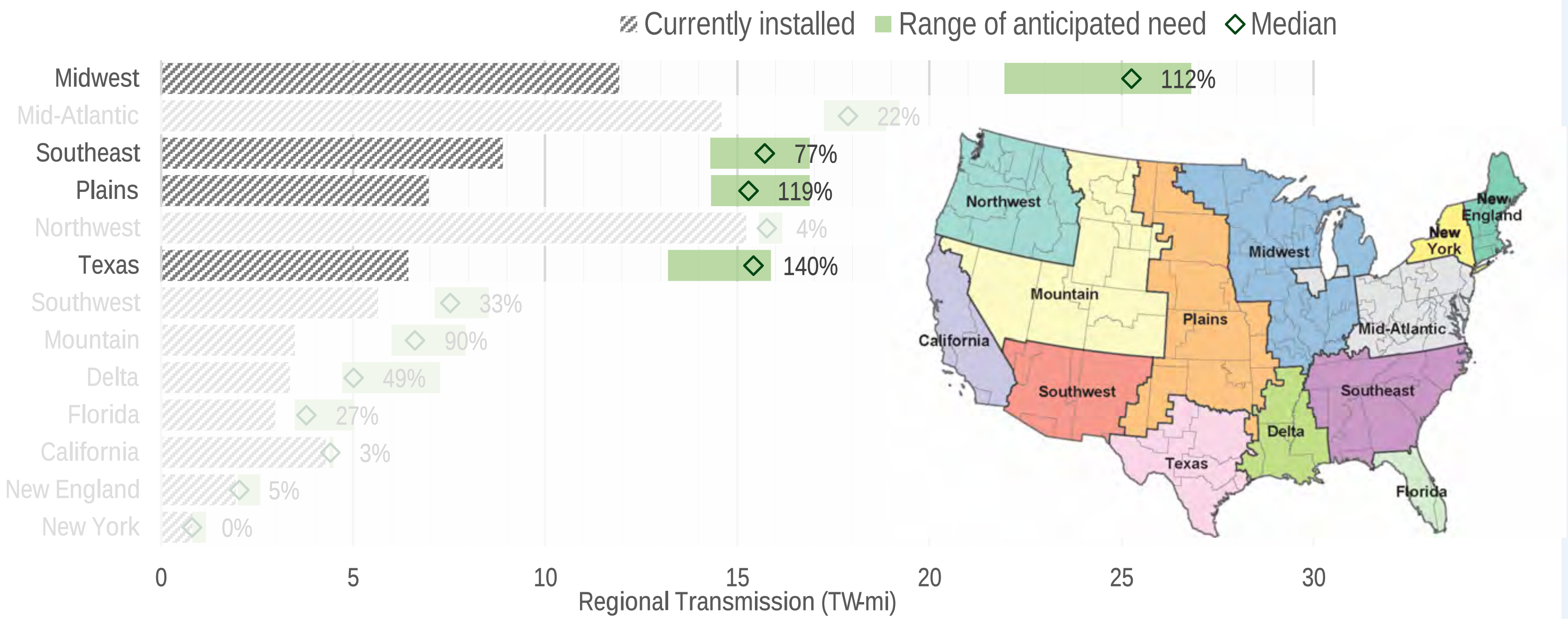
I'll just focus on the top four. The Midwest, Mid-Atlantic, Southeast, and Plains show a lot of total need by 2035. This is where we're going to see the most need for new transmission given the scenarios that were considered.

So, for the Midwest, the Plains, and then almost for the Southeast, that's nearly a doubling of the existing within region transmission.

However, for the Mid-Atlantic region, because there's so much transmission that's already been invested in the Mid-Atlantic, it's only a 20% increase to what they currently have.

Regional Transmission Expansion Results (2035 Mod/High)



Results of scenarios which enable a 2040 power system:

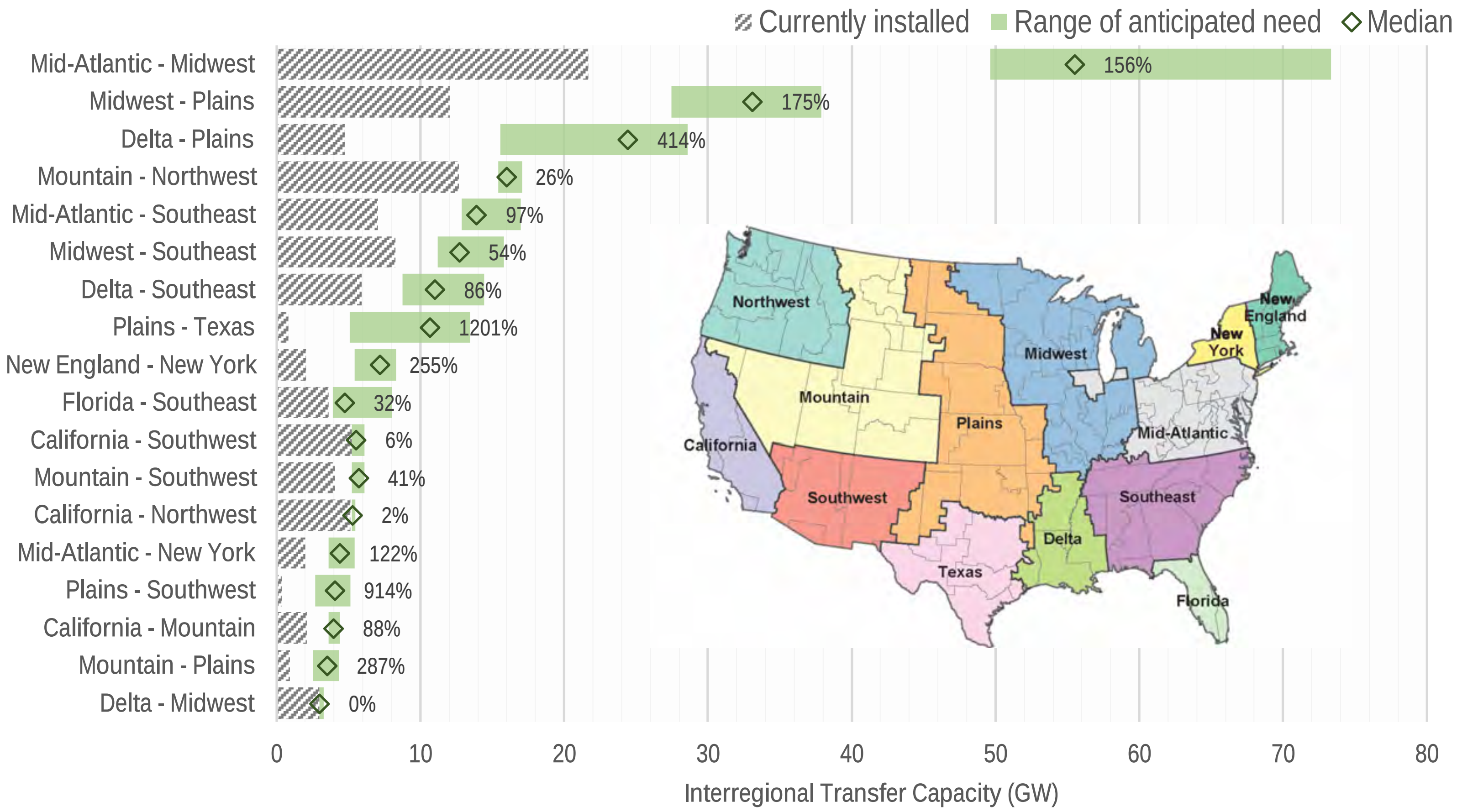
- 80% - 100% clean energy deployment
- 25% - 75% load growth
- Power sector decarbonization

This chart shows where there is the most *new* transmission needed.

So instead of the mid-Atlantic, we're now bringing Texas into the mix.

Texas is about in middle of the country's regions in terms of how much total transmission is going to be needed by 2035. But compared to what they have today, it's more than a doubling as well.

Interregional Transfer Capacity Expansion Results (2035 Mod/High)



We can do the same thing for interregional transfer capacity. So again, now we're looking at sharing between the regions. And we do this for all the different links that were studied by the six capacity expansion modeling reports.

Results of scenarios which enable a 2040 power system:
80% - 100% clean energy deployment | 25% - 75% load growth | 95 - 100% decarbonization from 2005 levels

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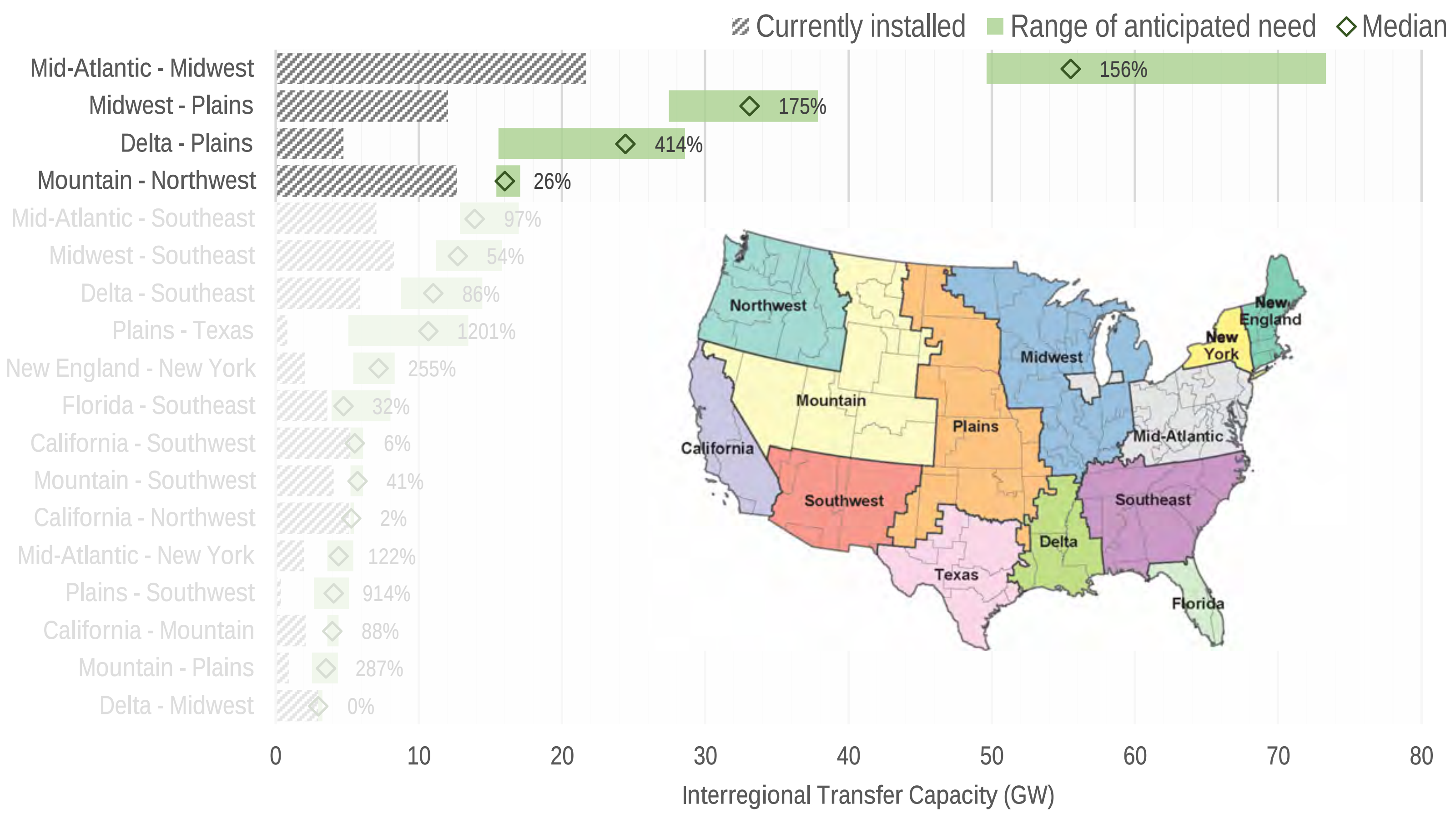
Interregional Transfer Capacity Expansion Results (2035 Mod/High)



I'm just going to highlight, again, those top four absolute transfer capacity needs.

The mid-Atlantic to the Midwest shows the most transfer capacity need.

Followed by the Midwest to the Plains, the Delta to the Plains, and then-- now moving from the Eastern Interconnection over to the Western Interconnection-- we have the Mountain and the Northwest regions.

For the Mountain to Northwest link, that's a relatively low relative transfer in terms of what currently exists; only a 26% increase to what they already have.

Results of scenarios which enable a 2040 power system:
80% - 100% clean energy deployment | 25% - 75% load growth | 95 - 100% decarbonization from 2005 levels

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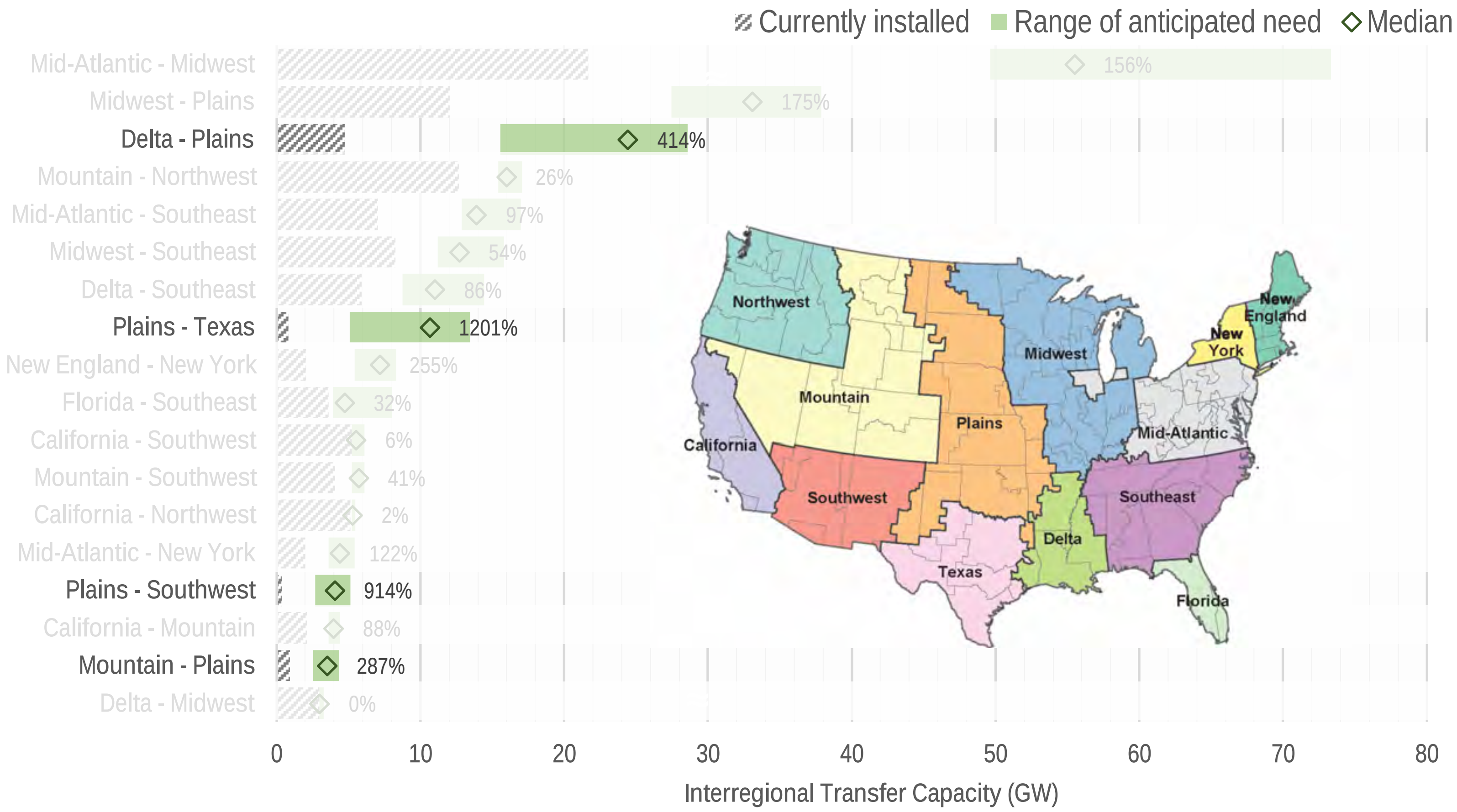
Interregional Transfer Capacity Expansion Results (2035 Mod/High)



So if we were to highlight where is the most new, *relative* need compared to what exists, these other regions pop out. The Delta to Plains link is still present. But now we also have Plains to Texas, Plains to the Southwest, and the Mountain to the Plains.

Now this tells, generally, the same story that we were seeing in the historical data and the literature review sections, where these cross-interconnection transfers are really where we see a lot of value. Between the Plains and Texas, that's connecting the Texas interconnection with the Eastern interconnection.

And these bottom two links--the Plains to Southwest and the Mountain to Plains--that's connecting the Eastern and the Western Interconnections.

There's very little transfer capacity between the three interconnections today, and we do see a lot of value in increasing those even though the total, absolute transfer capacity need is not that high compared to some of the other connections.

Results of scenarios which enable a 2040 power system:
80% - 100% clean energy deployment | 25% - 75% load growth | 95 - 100% decarbonization from 2005 levels

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I'm going to stop there to be sure we have lots of time for Q&A. Whitney, I'll hand it back to you to go over the Menti instructions again.

WHITNEY BELL: Great, thank you so much Adria. As she mentioned, we do have some time for Q&A. So go ahead and please put your questions into Menti now. There are several in there. We do ask that you are liking the questions that are in there now. The ones with the most votes will be the questions that we answer first. And we'll do our best to answer them all, but there are several in here.

So while everybody is getting in and you're upvoting your questions, I did want to answer the most common question we're receiving today. The presentations, the slides, and then a recording of today's webinar, will be available on the website in two weeks at the web page that will be in the chat momentarily. We will email you and let you know when these things are available.

All right, so let's go ahead and get started with these questions.

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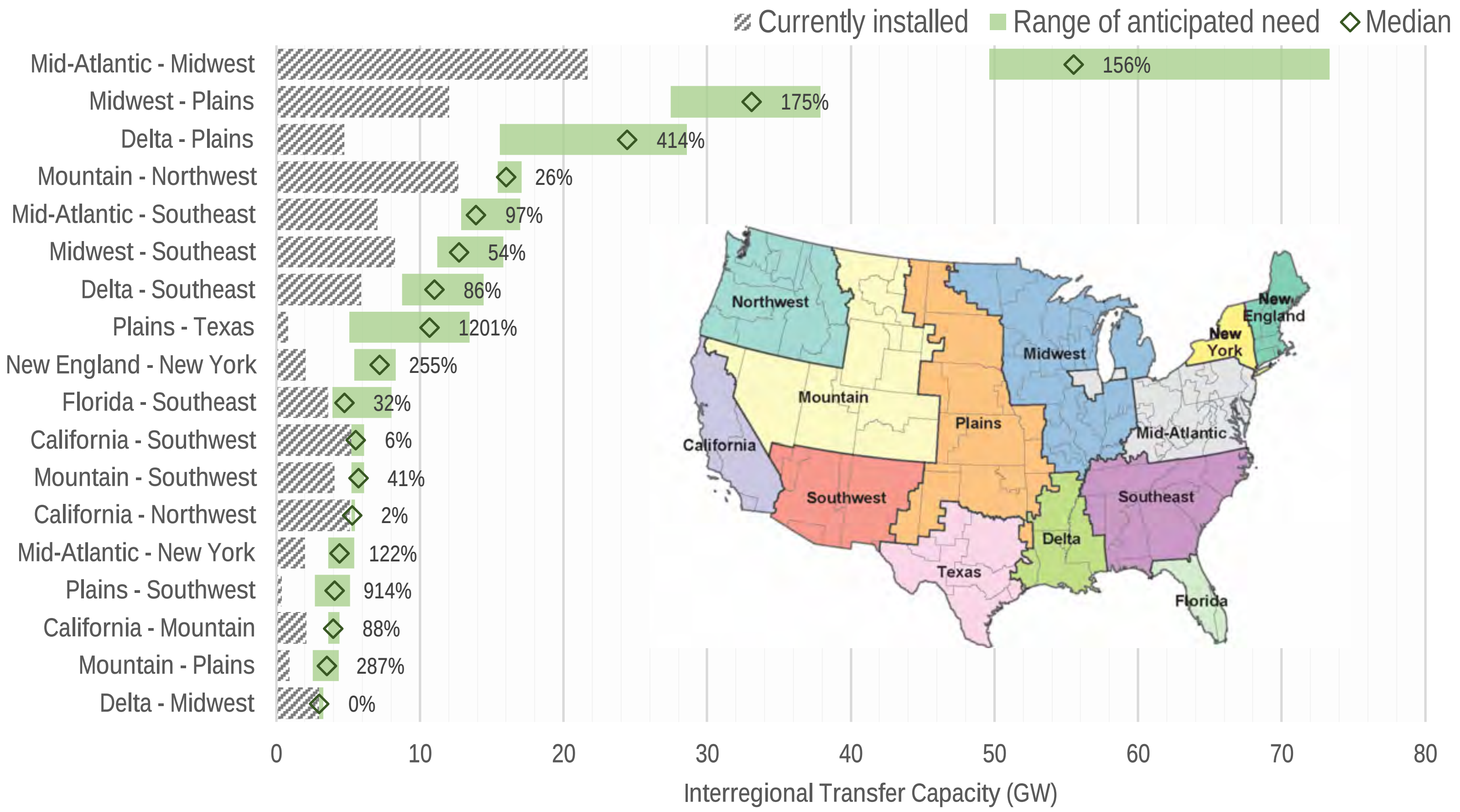
Interregional Transfer Capacity Expansion Results (2035 Mod/High)



Results of scenarios which enable a 2040 power system:
80% - 100% clean energy deployment | 25% - 75% load growth | 95 - 100% decarbonization from 2005 levels

The first question, why does the data show such small transfers between New England and New York, and are there any transfers with Canada?

ADRIA BROOKS: Great. I assume that that question is referring to this slide. You can see the anticipated future New York and New England transfer capacity need are about in the middle of all future transfers, which isn't a lot of transfer necessarily. I'll note a few things before I talk about Canada.

First of all, these are for the moderate load growth and high clean energy growth scenarios; our new normal. I'll note that both New York and New England do have very aggressive decarbonization goals, which would likely push them into the high/high scenario group; high load growth and high clean energy growth. And in those cases, we do see a lot more suggested need for additional transfer capacity between the two regions.

Though getting to the Canada piece, the only transfer that's shown here is between New England and a neighbor is with New York. Canada was not considered in capacity expansion modeling for the majority of the studies considered. There was one study that did consider it, but the majority of studies did not.

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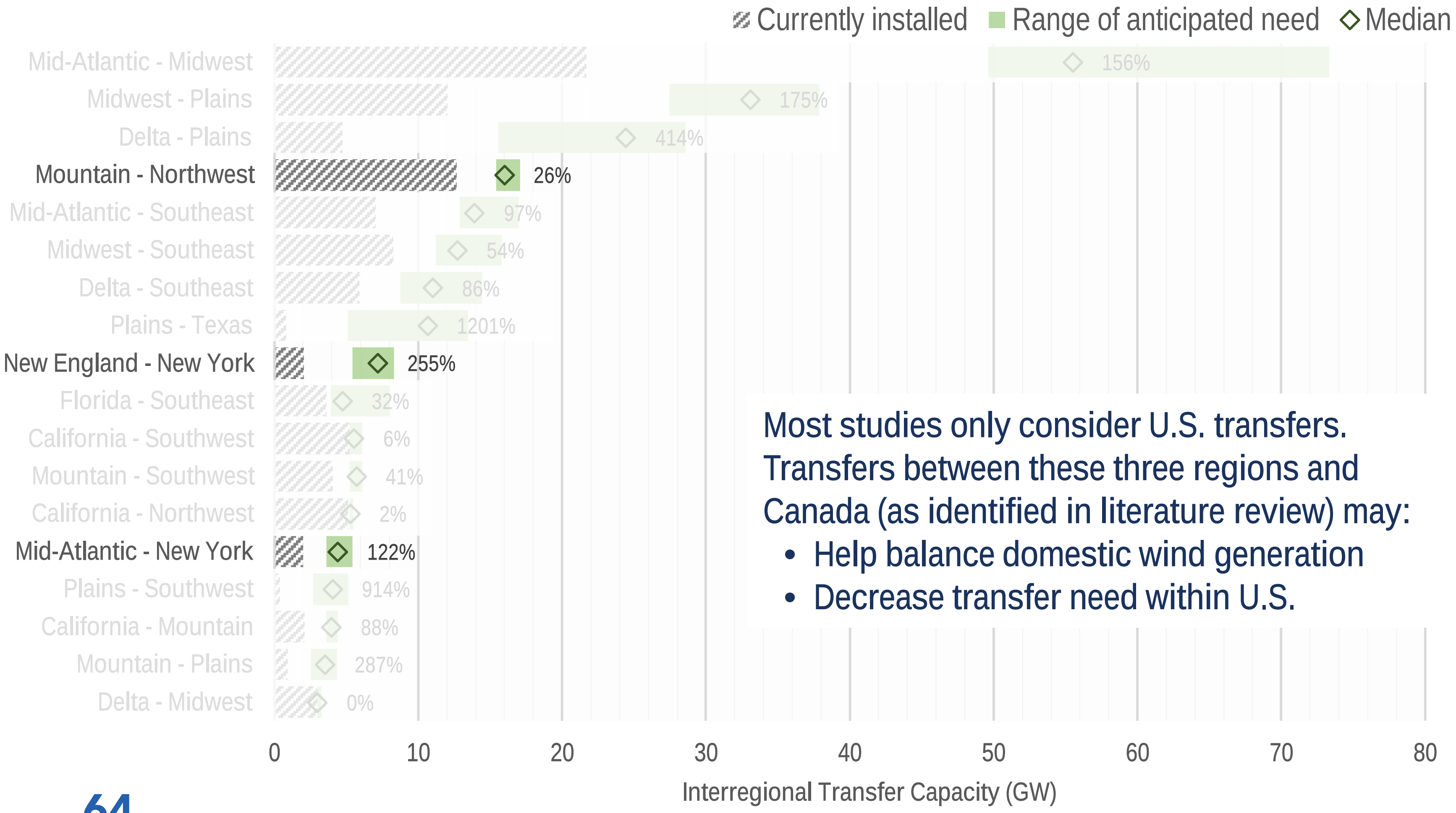
Interregional Transfer Capacity Expansion Results (2035 Mod/High) Potential changes with increased Canadian transfers



Most studies only consider U.S. transfers. Transfers between these three regions and Canada (as identified in literature review) may:

- Help balance domestic wind generation
- Decrease transfer need within U.S.

Results of scenarios which enable a 2040 power system:
80% - 100% clean energy deployment | 25% - 75% load growth | 95 - 100% decarbonization from 2005 levels

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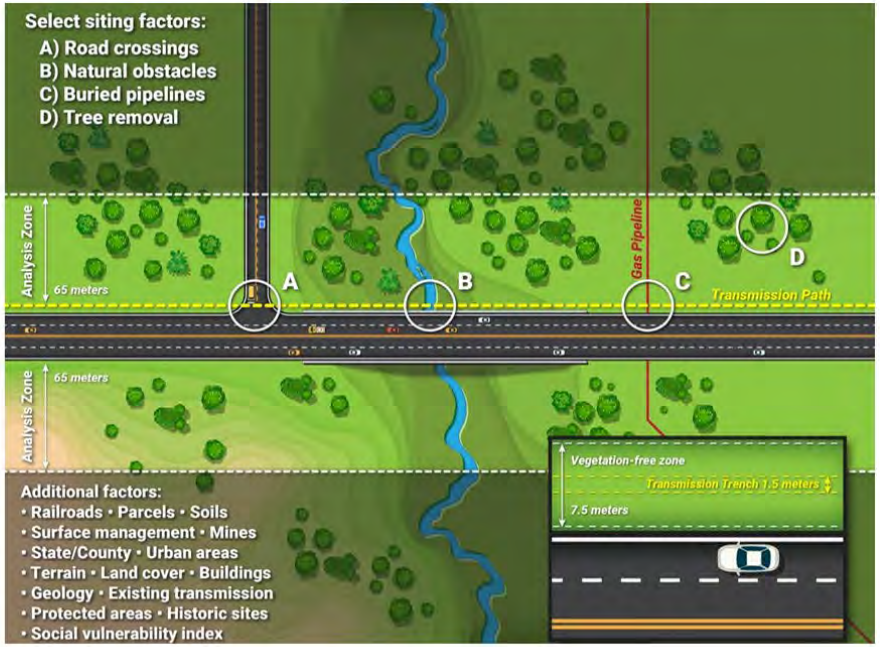
So it's reasonable to assume that the transfers between New England and New York, as well as the other regions that border Canada, their domestic transfers between other regions could decrease if they were to have extended or additional transfer capacity with Canada. And that was supported by a few different studies that we reviewed in Chapter V.

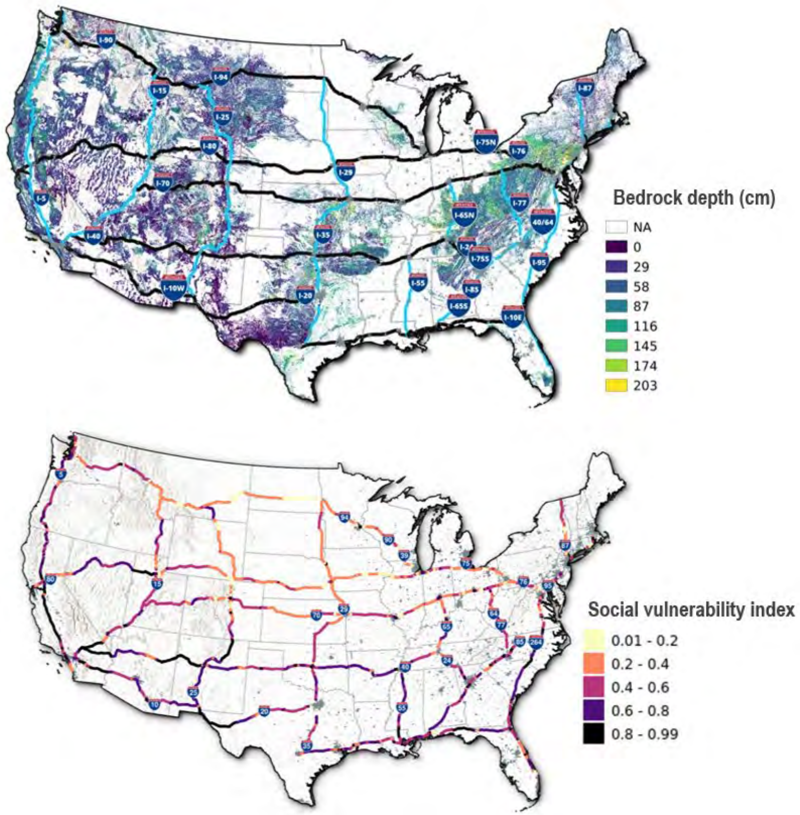
I've got a few slides on this… the transfers that are highlighted now-- so the Mountain to Northwest, New England to New York, and Mid-Atlantic to New York-- all of those have Canadian provinces above them that would be helpful to have additional transfers to.

The studies that were reviewed in Chapter V showed that there was increased value in additional international transfers for these specific regions. In which case, the anticipated transfer results shown here may decrease some. But not necessarily a one for one. There's not exactly the same value in interregional transfers with Canada as you have within the U.S. So, it's not a one for one, but I would expect something to shift here had the Canadian transfers been modeled in the capacity expansion studies used in this analysis.

Co-location of transmission corridors is possible in some cases.

Analysis of buried HVDC along interstate highways





Lopez, A. National Renewable Energy Lab (2023)

WHITNEY BELL: Great. Thank you. Next question. Instead of highways, would railways be another viable conduit for HVDC?

ADRIA BROOKS: Yeah, so the work that NREL did on the highways was the first of its kind to try to analyze this. There is discussion of extending that type of analysis out to other linear infrastructure. Linear infrastructure being the highways and rail as another example.

So, it is possible that rail right-of-ways could be useful for co-locating transmission in some circumstances. But of course, it's use dependent, or it's location dependent.

We don't necessarily expect that any transmission line located in the corridor of rail or highway is going to be ideal, but it's quite possible that there are specific use cases or locations where that would be useful.

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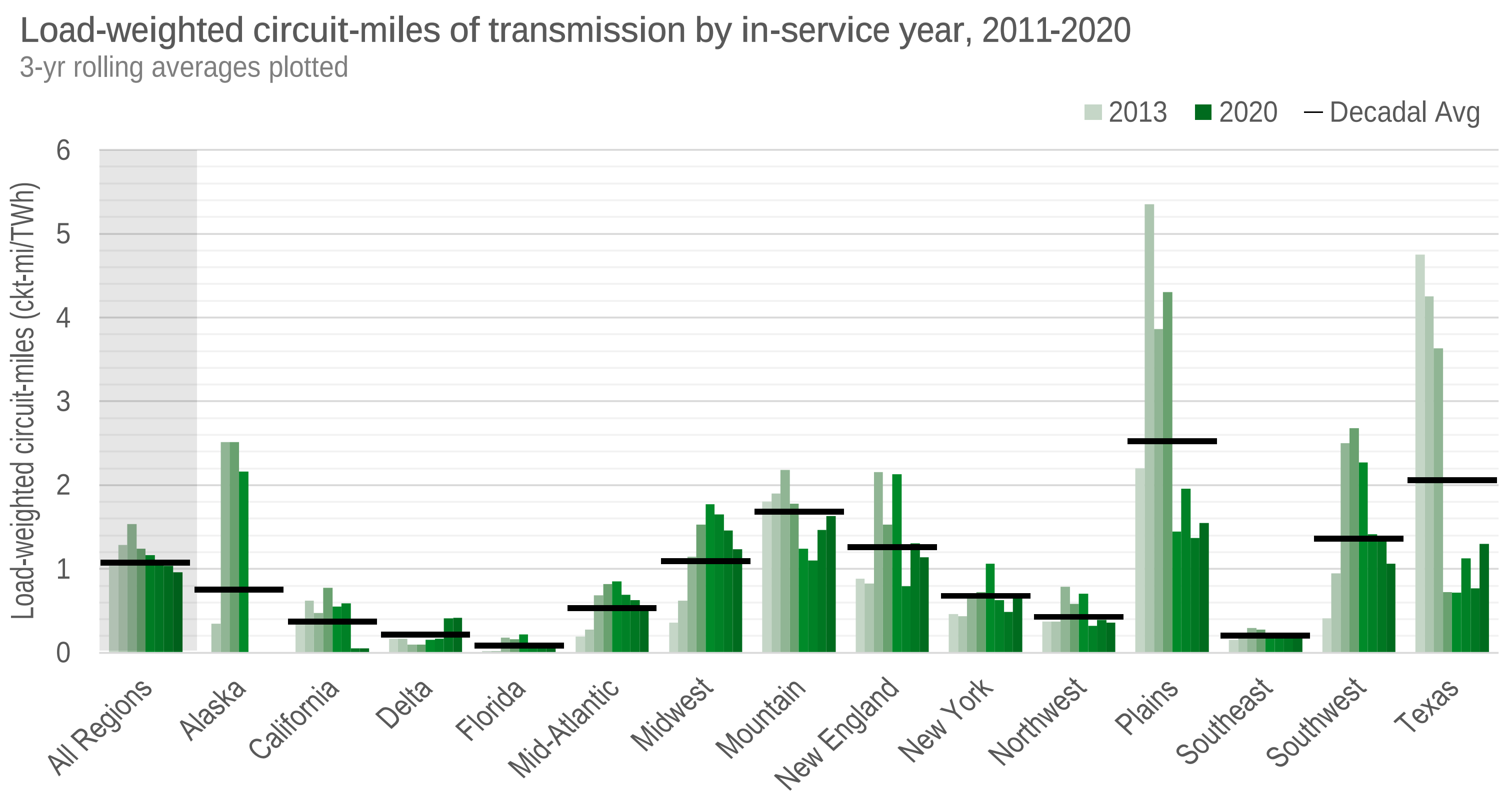
Transmission investments decreased during the second half of the 2010's.



Data from MAPSearch Transmission Database (2023). All transmission lines rated at or above 100kV.

WHITNEY BELL: Great. Let's see. What has caused investment in transmission to drop off since 2015? And do you expect transmission growth to increase again in the upcoming years?

ADRIA BROOKS: Unfortunately, I cannot answer that. We did not get into the reasoning behind why there was this decrease, but we did try to be transparent about where we're seeing the decreases within different regions.

Those who work in the transmission space within each region probably have a good idea for what's happening within their region specifically. But of course, it would be pretty unique to each region; there are going to be different reasons. Nationally, there might be a few trends, but for the most part, I wouldn't think these are going to be region specific.

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National Trends in Transmission Lines Installation between 2011 and 2020

National trends in high-capacity lines dominated by Texas (CREZ).

National trends in economic lines dominated by Texas, Midwest, Southwest, and Mountain.

National trends in multiple driver lines dominated by Midwest (MVP).

Data from MAPSearch Transmission Database (2023). All transmission lines rated at or above 100kV.

WHITNEY BELL: Thank you. So what were the drivers behind the high capacity transmission builds in the US in 2011 to 2013?

ADRIA BROOKS: I can show the regional breakdown to help answer this question. Shown here this is the same data, but now it's broken out by region. Those high-capacity lines are in blue. Those are dominated by the lines in Texas, so the upper left portion of this chart, where we see a lot of high-capacity lines being installed in 2011, 2012, and especially 2013. These are the CREZ projects— the Competitive Renewable Energy Zone projects— that ERCOT invested a lot in during the first half of the decade. These projects are really dominating the entire national trends just because of how much transmission was installed in Texas druing those years.
Other regions that have large high-capacity lines--California was another one that invested a lot in 2016. So we do see kind of a blip in 2016 in that national chart because of the investments made in California. But dominantly, it's Texas and the CREZ lines there.

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Additional transmission capacity could come from multiple technologies; not all from new traditional "poles and wires"

What is a MW-mi of transmission deployment? Approximate power carrying capabilities (MW) of uncompensated AC transmission lines at different voltage ratings and lengths from NRRI (1987).

Nominal Voltage (kV) → Line Length (miles) ↓	138	161	230	345	500	765
50	145	195	390	1,260	3,040	6,820
100	100	130	265	860	2,080	4,660
200	60	85	170	545	1,320	2,950
300	50	65	130	420	1,010	2,270
400	NA	NA	105	335	810	1,820
500	NA	NA	NA	280	680	1,520
600	NA	NA	NA	250	600	1,340

WHITNEY BELL: Thank you so much. Are non-wires alternatives included in the capacity expansion modeling findings?

ADRIA BROOKS: So, yes and no. I'll talk first about the way that transmission expansion is modeled in the capacity expansion modeling.

I didn't point this out previously, but those who were paying attention have seen that we're measuring new transmission as gigawatt-miles or megawatt-miles. That value does not mean much in the industry because usually in the industry we talk about kilovolt-miles, a measurement of the size of the line multiplied by its distance, or how long it is.

A megawatt-mile is meant to describe what is the amount of carrying capacity along a transmission line, and then multiplied by the length of that line. One reason to use this in capacity expansion modeling is because it can be considered technology agnostic. So instead of assuming that you have to install new poles and wires to meet this new transmission need, you can just increase the carrying capacity of the existing infrastructure. And then that would help increase new carrying capacity, and new megawatt-miles.

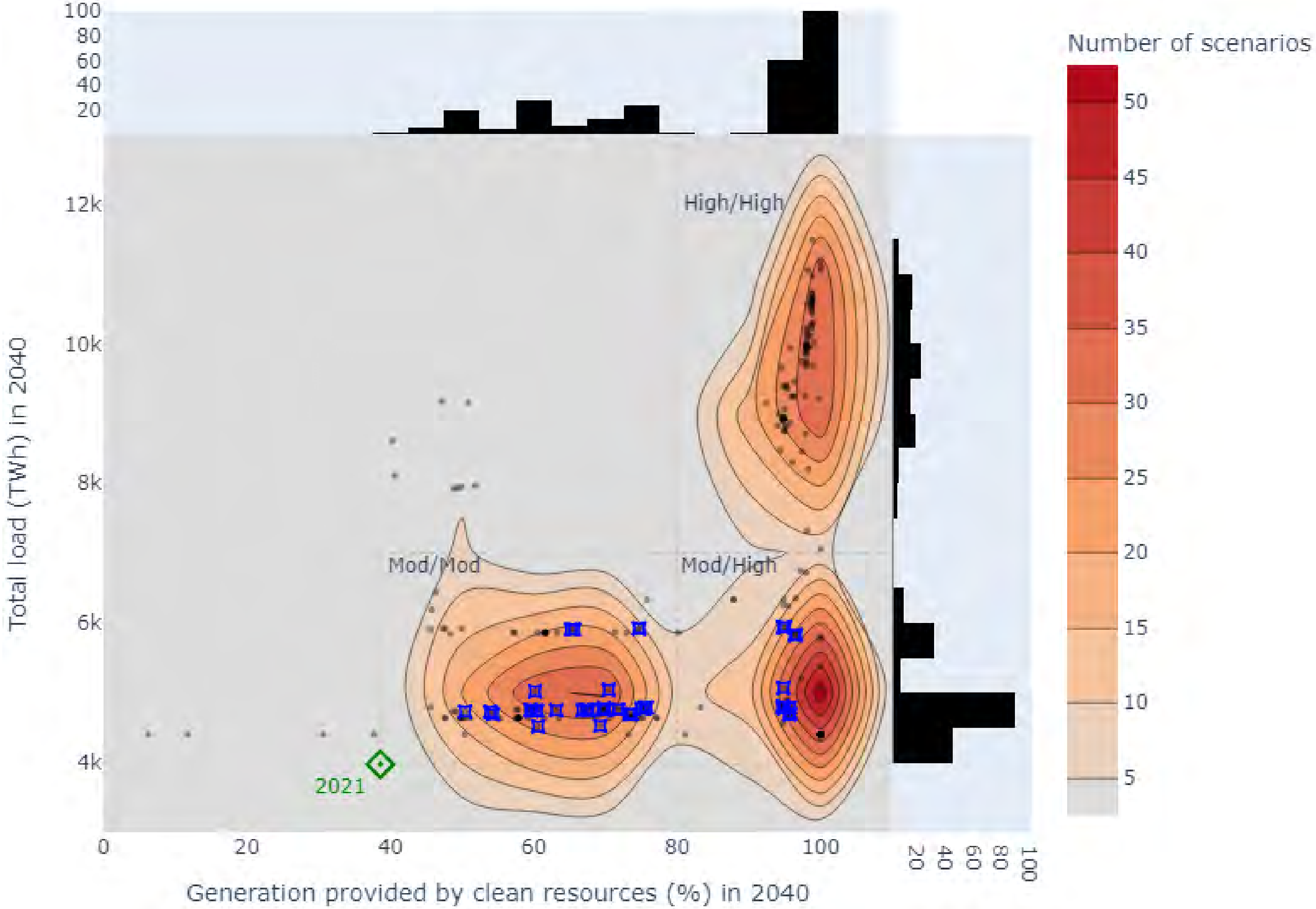
Dynamic line ratings are an example of a technology that does this. You can invest in those on the existing transmission system to help increase the megawatt-miles of the line.

So in that regard, we do have alternative transmission solutions considered. New poles and wires are going to be required to some extent, but you can make up a lot of the new capacity that we're seeing in the results using existing technologies.

Alternative transmission solutions (notably, DERs and storage) are represented in capacity expansion models

47 scenarios (blue boxes) considered at least 200 TWh of annual energy production from DERs.

200 TWh benchmark from *Why Local Solar for All Costs Less* (Clack et al. 2020)



So that's the first answer to the question. The next is related to the ways that distribute energy resources and storage-- which are considered other alternative transmission technologies--were modeled specifically in the capacity expansion results.

There's a lot of storage included in the scenarios, particularly the scenarios in the moderate/high and the high/high categories. A lot more storage than what we're seeing deployed today, even if we were to continue to install at today's levels.

There are a lot of distributed energy resources that were assumed in the scenarios as well. On this chart, those blue boxes are highlighting the scenarios that had really high distributed energy resource penetration.

This points out that, while distributing energy resources can help reduce the amount of transmission need in the U.S., we're still seeing significant transmission need even if we assume a lot more distributing energy resources come online in the future.

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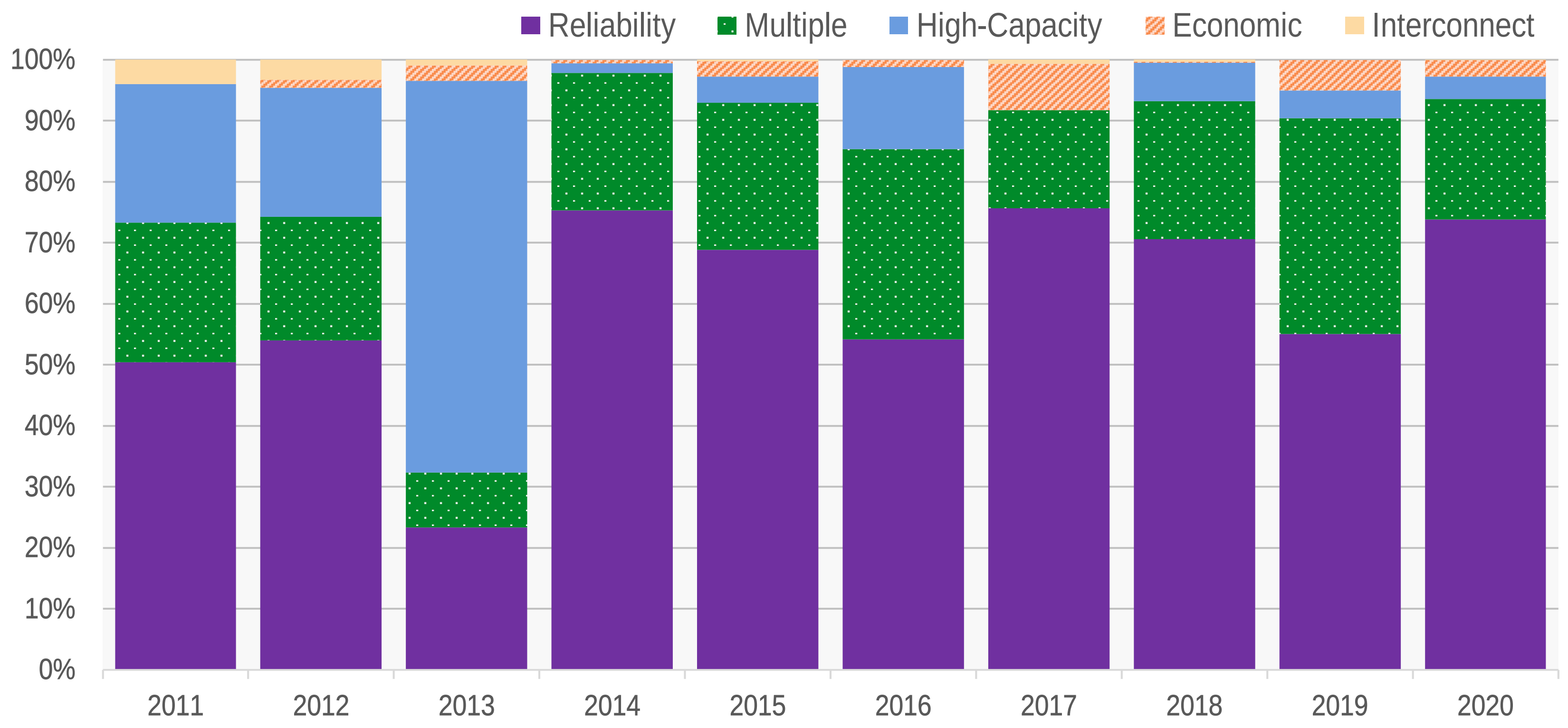
Incremental, local reliability needs were the primary driver of transmission investments in most regions.

Proportion of national circuit-miles installed each year by project driver



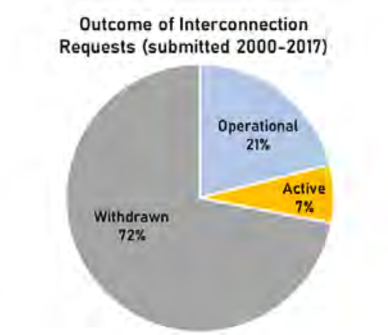
Data from MAPSearch Transmission Database (2023). All transmission lines rated at or above 100kV.

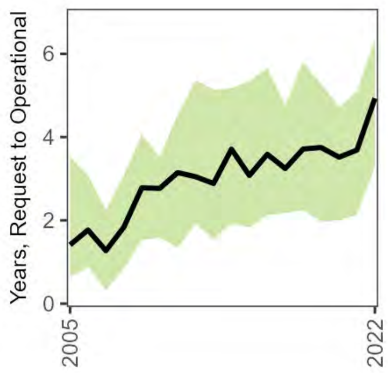
WHITNEY BELL: Thank you so much. So on slide 26, it showed that most driver of transmission investment is because of reliability. But then it says in slide 27 and 28 it looks like more needed-- more need related to market efficiency instead of reliability. Why is that?

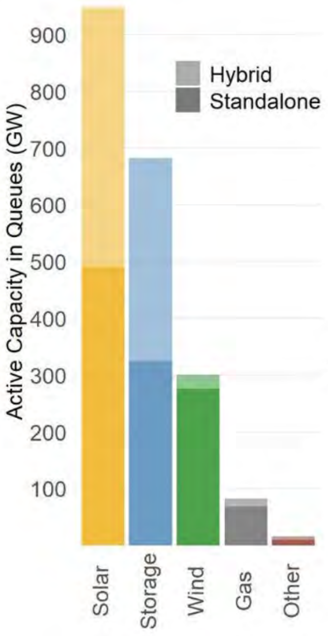
ADRIA BROOKS: So we didn't get into the why in regard to the historical data. I'll note that the reliability of those local reliability needs shown here, those are the lower voltage lines in the 100 kV to 200 kV range. In many regions of the country, those are considered easier to site and install than maybe the higher voltage transmission lines that are needed to really make up some of the differences here that we see to alleviate the high prices shown on slides 27 and 28, and especially to meet a lot of the interregional transmission need.

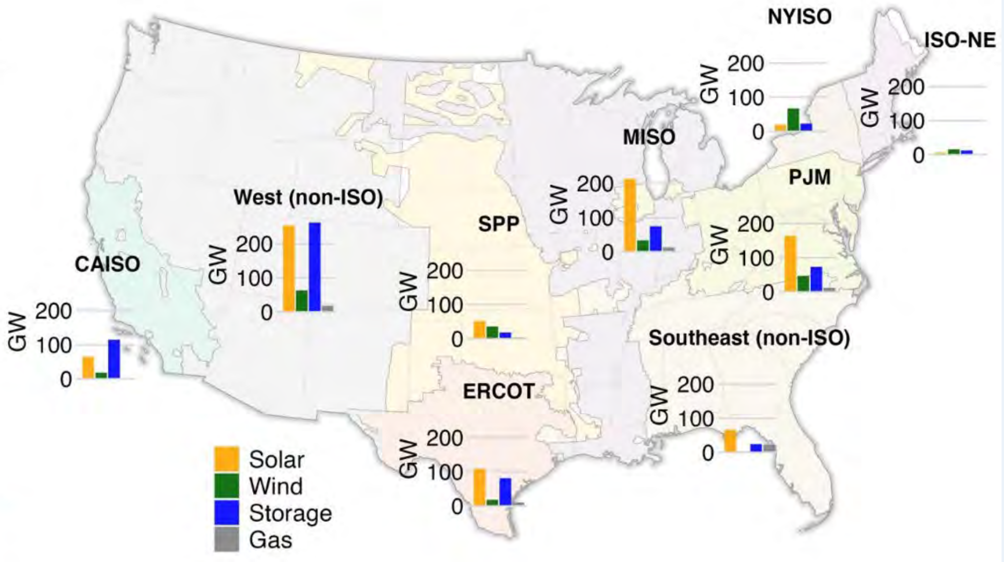
So the apparent conflict between reliability results on slides 26 and 27 reflect the differences in the type of transmission that's needed and the ease or availability to buildout those different transmission types in different parts of the country. Higher voltage, interregional transmission shown as needed on slides 27 and 28 is more expensive and often harder to build in many places, whereas those smaller, lower-voltage lines represented on slide 26 are easier to build.

Generation is waiting longer to connect to the transmission system.









DOE / LBNL, *Queued Up But in Need of Transmission*
[ESIG webinar recording link]

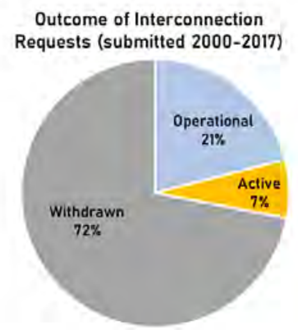
WHITNEY BELL: Thank you. All right, related to reliability and resilience, does the report consider interconnection delays-- for example, energy storage system-- as a gap or need? In ISO New England we have an interconnection delay up to eight years. Like 30,000 MW in the queue.

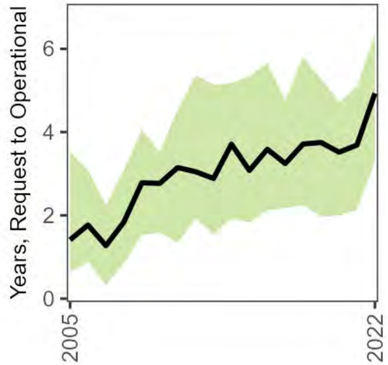
ADRIA BROOKS: Yes, we do include that in the new version of the study. And I'll pull up just a background slide on it. I'll describe a little bit about what an interconnection queue is for those in the audience that aren't familiar with it.

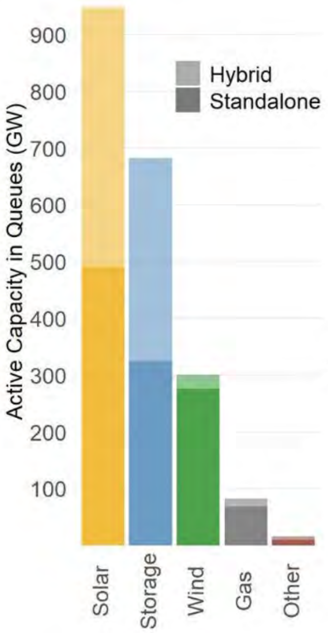
When a new generator wants to connect to the power grid, they have to enter into what's called the *interconnection queue*, which sets them up to do reliability studies with the transmission planner. The planner, or the operator, wants to be sure that this generator is not going to cause reliability issues on the power grid. You must do a number of engineering studies to ensure that.

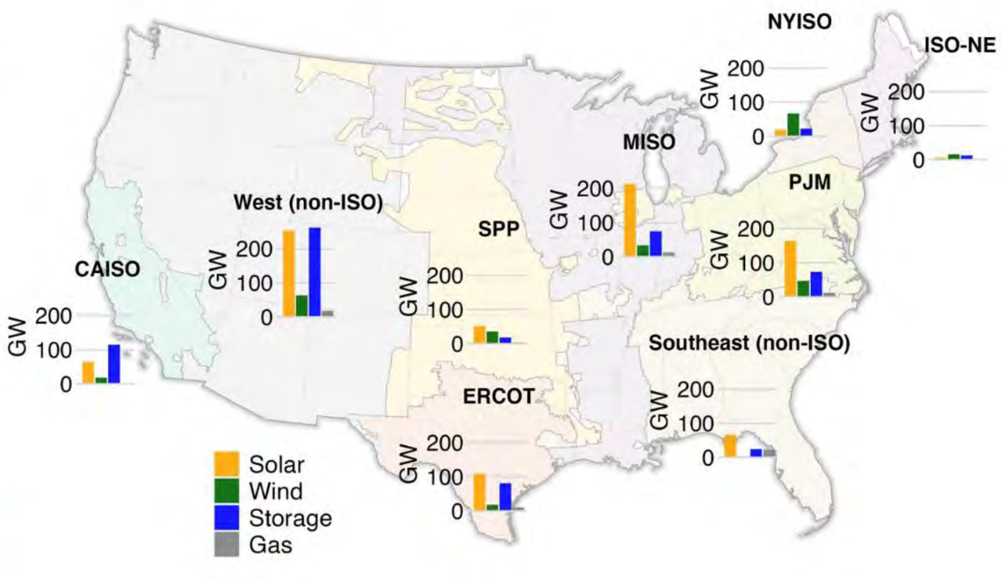
So, when the generator enters the queue, they're getting in line to have these type of engineering analyses done. And then at the end of that analysis, they'll say, OK, this is how many grid upgrades would be required to install this generator. And then usually those upgrade costs are handed to the generator for them to decide if they are willing to make those grid upgrades so they can connect.

Generation is waiting longer to connect to the transmission system.









DOE / LBNL, *Queued Up But in Need of Transmission*
[ESIG webinar recording link]

We do talk about interconnection queues in the Needs Study. Here's just a snapshot of the information that's in the study.

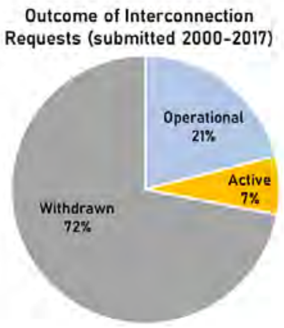
In the middle of the slide -- the bar chart and the map on the right -- these are the types of generation technologies that are looking to connect to the power grid today.

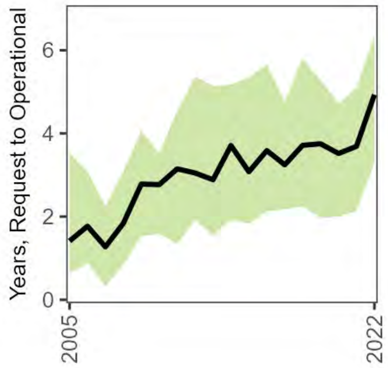
The main bar chart in the middle, these are the data across the entire nation. There's a whole lot of storage (in blue) and solar (in yellow) in the interconnection queues. There's also a good amount of wind. Less so for gas and other (e.g., coal, nuclear and geothermal) facilities. So that's the data for the nation.

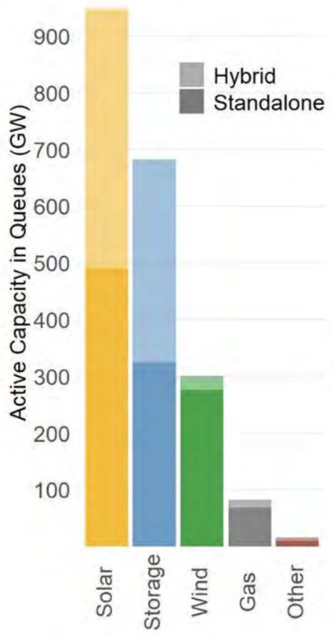
And then you can see it broken out by the different transmission planning regions as well by looking at the smaller bar charts on the map. There is a lot of solar, predominantly, in the queues in nearly all regions. But then, again, large amounts of storage throughout the nation and wind in some regions.

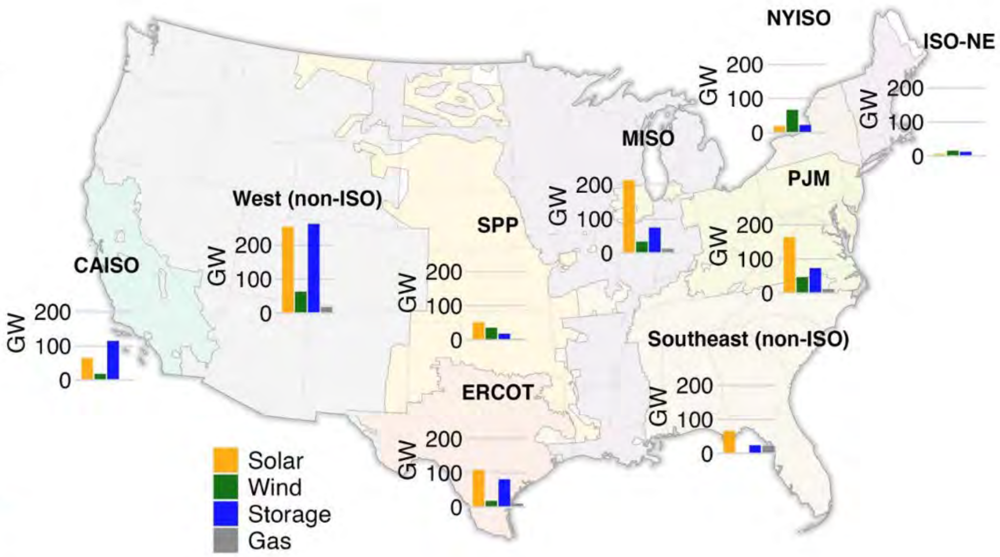
If you look at the bottom left, this line chart shows the length of time-- the median length of time-- that generators are waiting to connect. So, in 2005 the interconnection queue process took about two years to complete? Now the queues are lasting, on average, five years. And in some regions of the country even longer.

Generation is waiting longer to connect to the transmission system.









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So there's a number of reasons for this. It's hard to distill the specific reason just from looking at the national data. One reason, though, that we point to is that, because the transmission system is just so much more congested-- we're really pushing the limits of the existing system-- it's possible that a generator who wants to connect in one state is going to cause reliability issues a whole other state or two over. And they're going to be asked to deal with those costs or to upgrade the system a few states over in order to connect their generator.

That wasn't as much of a problem earlier when we weren't pushing the transmission system quite as hard as we are today. This is one reason why we're seeing these longer interconnection queue times and why so many generators are leaving the interconnection process.

The pie chart shows the number of projects that enter and then ultimately withdraw from the interconnection queue process. So nearly 75% of 3/4 of all generators that enter the queue process wind up withdrawing for one reason or another.

So we start to get at an answer to that initial question, although we don't have an exact answer to the New England question, specifically. But we do talk about it at the national level.

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WHITNEY BELL: Thank you for that thorough explanation. I appreciate it. Will the results of this study inform the decision making process for the second round of GRIP funding?

ADRIA BROOKS: So the Grid Resilience and Innovation Partnership (GRIP) Program funding was referring to another program within the Grid Deployment Office that's funding resilience projects. The Needs Study is going to help inform program staff's understanding of the power grid, and it does inform some very specific funding and regulatory mechanisms like the National Interest Electric Transmission Corridors. But there's not a direct link in statute between the GRIP funding and the Needs Study.

I will just leave it there. Although, of course, more specific questions could be asked to the GRIP team, which isn't the same team that worked on the Needs Study.

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WHITNEY BELL: Is there detail behind which interconnection would be the primary beneficiary if transmission is expanded between the Eastern and Western interconnection?

ADRIA BROOKS: There's a little bit of discussion on this in the Needs Study. The idea is that, as you connect to the Eastern and the Western Interconnections, there's additional-- both economic as well as reliability-- benefits to doing that. To say that there's one primary benefit to either the East or the West, I'm not certain that I could say that. Kind of average across all the country-- considering all the time.

But in very specific, extreme events, there would be a very direct benefit to either one. So it could be both, depending on which region the country is experiencing a really bad storm, for example, or they're having a lot of transmission outages due to a weather-related event or a cyberattack. So having additional interconnection really can benefit both Interconnections in these specific, isolated cases. But I don't know that I could say which one would benefit more just on average.

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WHITNEY BELL: Understood. Will the data and simulation files that were used in these findings be publicly shared?

ADRIA BROOKS: We only use publicly available data. So the data, in the case of the capacity expansion modeling data used in Chapter VI, could be obtained from either the academic institutes or the National Renewable Energy Laboratory. We haven't had discussion about publishing the data analysis that we have done more than what is available in the Needs Study, but to the extent that we try to only use publicly accessible data, a lot of the analysis should be repeatable.

And I don't know that we said this in the beginning, but there is a Supplemental Material, or a methodology, document that outlines how we did the data analysis throughout the study. That is available on the same web page where you can get the Needs Study. That should give more information about how to repeat this analysis.

And I'm also happy to have follow up conversations with whomever asked if there's a specific use case they need for the data.

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WHITNEY BELL: Thank you so much. And we'll be sure to include that information in our note to everybody as well, letting them know that is on the site as well.

How does the capacity expansion modeling conducted under the NTNS relate to the National Transmission Planning Study work?

ADRIA BROOKS: Sure. So, the NTNS— some folks have referred to the National Transmission Needs Study under that acronym, but we're not using that acronym. We just referring to it as the *Needs Study* to simplify things and reduce the number of acronyms. I'll note that the National Transmission Planning Study is very similarly named, which can lead to confusion.

So, the Needs Study is meant as an assessment of currently or already published work, data sources or studies. It's not meant to do new modeling, as Jesse discussed in the beginning.

The National Transmission Planning Study is the Department's effort-- working with the National Renewable Energy Laboratory and the Pacific Northwest National Laboratory-- to repeat at the national level many of the modeling efforts that transmission planners, within their different regions, do when they assess how much new transmission is needed in future years.

We're trying to replicate those models looking at the entire continent-wide power grid. There is a lot of new modeling and a lot of new analysis, that's coming out of that National Transmission Planning Study work.

In terms of the actual data or models used, the capacity expansion modeling that was used in Chapter VI of the Needs Study does rely on some of the same models that are being used in the capacity expansion modeling for the National Transmission Planning Study. But I'll note that a lot more modeling is being done in addition to capacity expansion modeling in the Planning Study; the capacity expansion modeling is just one piece of many different tools and many different analyses that we're doing in the Planning Study.

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WHITNEY BELL: Thank you. Is there any data on the need for HVDC versus AC?

ADRIA BROOKS: We did not get into the different technology uses; we did try to be pretty technology agnostic. So, throughout the report when we discuss a need for new transmission. that could be HVDC, AC, or it could be alternative transmission technologies. Essentially, any technology that could serve the need is considered *transmission*.
Of course, those who develop transmission will know that there's different use cases when you'd want to use DC versus AC, but we don't get into that in the Needs Study itself.

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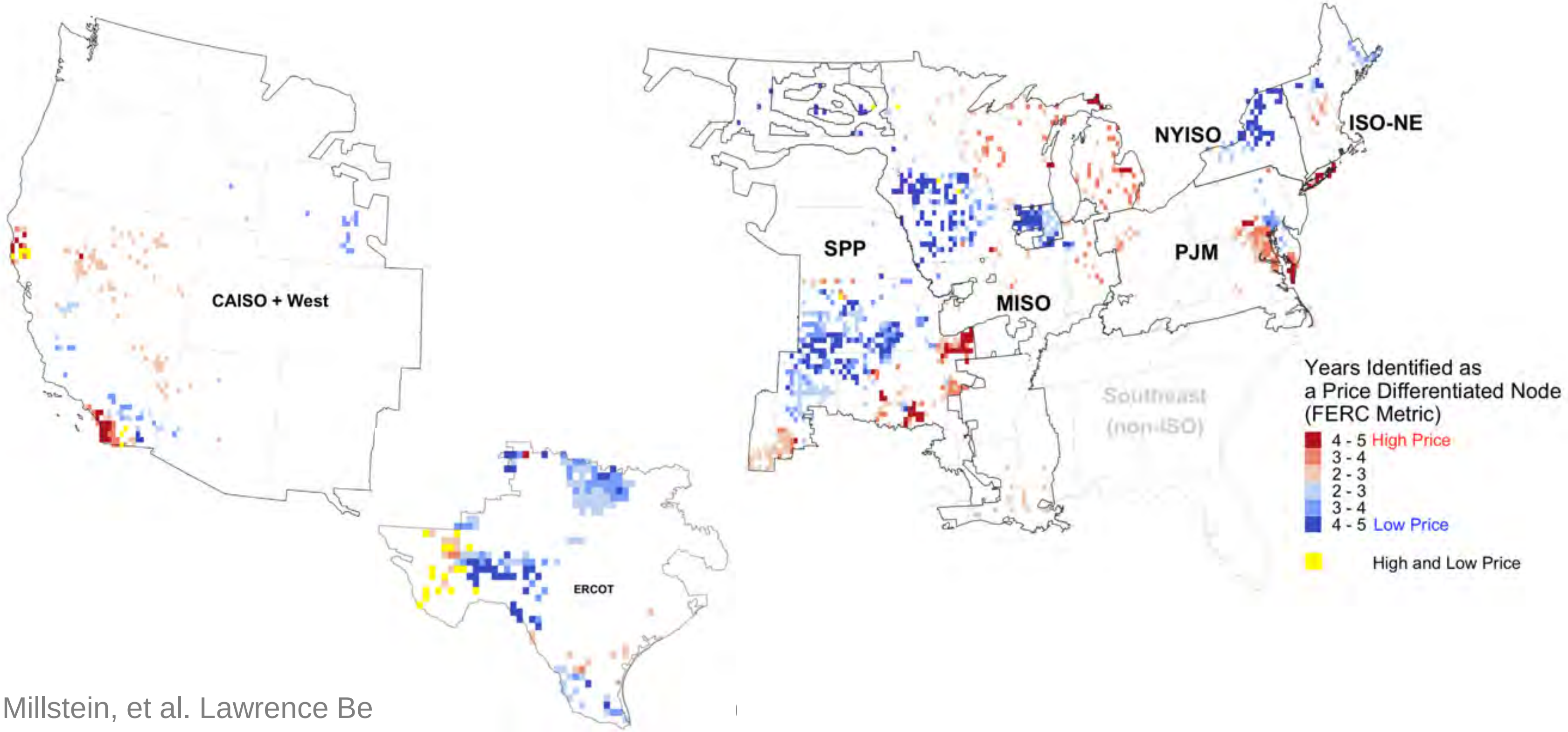
Regional price differences highlight locations of persistently high electricity prices.

The Market Price Differential metric helps identify opportunities for transmission, even when grouping all interconnect regions together.



Millstein, et al. Lawrence Be

WHITNEY BELL: Great. I think we've got about time for two more questions. On slide 27, what is the definition of electricity cost? Transmission only? Generation only? Fully bundled? Et cetera. Also, how is high cost and low cost measured/defined?

ADRIA BROOKS: Great. The “cost” shown here, these are just wholesale prices; so, dollars per megawatt hour. The locational marginal prices within each region were used. I should have noted this on this slide, but that's the reason why the Southeast here is grayed out. It's because the Southeast does not use locational marginal prices, so we don't have historic wholesale electricity prices that we can use in this analysis.

When we talk about how *persistence* is measured, we're looking at what is the average price at that location-- so all the little squares that show up on this map-- compared to the median of the entire interconnect.

In the West and in Texas, those are pretty well isolated because it's the same market for the entire Interconnection. But in the East, there are many different RTOs and planning regions (e.g., PJM). We're looking at the comparison across the median wholesale price at that hour for the entire Eastern Interconnection to determine if a price at a specific node is persistently high or persistently low.

There's a lot more information in the underlying analysis itself-- which I just put the name of the published study in gray underneath California there— that you can go in to try to understand exactly what they did. And this information is also in that Supplemental Material document for the Needs Study.

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WHITNEY BELL: Great. And then one last question. Are you doing a study overlapping capacity expansion with current telecommunications plus broadband backbone under FCC's jurisdiction?

ADRIA BROOKS: So I can't speak to what studies are being done across the entire Department. We are not looking at that in either the Needs Study or in the National Transmission Planning Study, which are being run out of the Grid Deployment Office. But it's possible that Office of Electricity or the Office of Cybersecurity, Energy Security, and Emergency Response (CESER) might be looking at something related. But I can't say for sure.

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WHITNEY BELL: Great. Thank you so much.

This does bring us to where we're about out of time for today. I did want to say there are still several remaining questions here, but the program team will review the remaining questions and they'll use them to inform an online FAQ, and we'll be able to share that out when we share the information of the website with the presentation and the recording.

So just so you all know, we're not going to forget your questions. As we know, there are many, many more in here. And these are all very excellent questions. We really appreciate everybody's time today on those.

This does wrap up today's webinar. If you do have any additional questions on the National Transmission Needs Study, you can email them at NeedsStudy.Comments@hq.doe.gov.

So, thank you Adria, Jesse, and Maria for joining us today. And thank you to all of our attendees and all of your great questions. We really appreciate it. Take care everyone, and we will see you next time.

Thank you!

NeedsStudy.Comments@hq.doe.gov

https://www.energy.gov/gdo/national-transmission-needs-study