**Q1 2024 Quarterly Report Findings, Insight, and Q&A Webinar Transcript**

**Carl Ostridge:** Okay, it looks like we've got good numbers here now, so we're going to get started. So, yeah, thanks everyone for joining. This is the quarterly market report webinar for Q1 of 2024. You have myself, Carl Ostridge, and my colleague, Devon Lukas. We're going to be presenting today on the content that we had in the market report, as well as some additional content for you all. Before we get started, just a few quick administrative notes. So we are recording the webinar and then we'll make that recording available to everyone who's registered shortly after the webinar is completed. If you have questions, there's the Q&A function in Zoom, so please use that to ask questions as we go along. And then when we get to the end of the content, we'll cover as much of those and answer as many of them as we can. So I'll cover a quick introduction in a second. After that, we have two topics. Devon is going to present a deeper dive on recent solar generation records in ERCOT, and then I will talk through some of the trends in wind and solar value that we're seeing in Q1 of 2024 and some of the underlying drivers.

So first, a quick intro to the webinars and the reports. We create these State of the Renewables Market reports every quarter, and the aim there is to create some data-driven insights that we are seeing in value for renewable energy across the country. So we have domain expertise at REsurety covering power markets, atmospheric science, and renewable energy offtake. And we use that to analyze all of the data that goes into these reports. We're data geeks, so we use as much data as we can. All of the metrics and all of the calculations that we're presenting here and in the report use hourly data. So we have hourly generation and price data concurrent with one another to go into the metrics and expose the weather driven trends that are present. All of the data is then curated by our team of experts and then we make it available in the reports, in this webinar, and then also via our software platform.

So now with all of that out of the way, I will hand it off to Devon. She's going to explain why there's more than meets the eye when it comes to the recent record-breaking solar output levels in ERCOT.

**Devon Lukas:** Great, thank you, Carl. So, as Carl mentioned, we spent some time thinking about the record-breaking solar in ERCOT this quarter, and what's actually going on behind the scenes there. So over the past few years, solar records have been happening a lot more frequently, and it would be pretty hard to ignore the massive amounts of solar build out in ERCOT. In the past five years, the maximum solar output has grown from just one gigawatt in 2019 to over 18 gigawatts in this past March. And that growth has been skyrocketing in 2024 with roughly three and a half gigawatts of output added each year since 2020. And we're already at five gigawatts of increase from 2023, only through this first quarter of the year. So this, of course, is going to fundamentally change the grid stack and ERCOT and have a meaningful impact on the market and power prices. But there is a bit going on behind the scenes, as this massive increase in development does not always directly translate to actual output. And this causes actual potential output for solar to be missed. So most notably, solar curtailment played a big role here, and we'll be diving into that over the next few slides.

So there's multiple drivers behind solar curtailment, and these drivers have to be sort of just right for a solar output record to actually be hit. Firstly, when load is low, there's less demand and therefore less generators need to be running. But when we pair that with high renewable generation, most of that load is being met and this can lead to low prices and drive curtailment of resources. And then moving along the top row there. Additionally, if projects are bound by transmission constraints, power cannot reach consumers. Even if demand is high, actually, local constraints can still cause curtailment even if power cannot get where it is needed. And with low prices, generators no longer need to keep running. But there is an intricacy here for wind projects eligible for the production tax credit. So these projects will continue to keep generating even at low and negative prices, forcing solar to curtail first, as those projects are often receiving the investment tax credit instead at the time of build, rather than a production based one. So low prices overall cause renewable curtailment, but tax incentives is what causes solar curtailment specifically over wind.

So due to these drivers of curtailment, conditions need to be just right for a new solar record to actually be broken. And we saw these drivers of curtailment in action over the past quarter. So in this plot here, we have hours over the quarter showing curtailment as a function of net load, where net load represents just the total load minus renewable generation. So that's a function of both wind and solar generation. So the blue dots here represent record breaking hours while the green represent missed ones caused by curtailment. And as you can see here as the net low drops below that 25 gigawatt line, solar generation curtails, as we move along the right axis, towards the right on the x axis. And in contrast, these blue records are able to be broken due to higher net load and minimal renewable curtailment. So for net load to be high and for solar records to be broken, since it's a function of both wind and solar, wind generation needs to be low, which is something to keep in mind for the next slides as we check out an example of each of these blue and green scenarios.

So first, let's look at an example of when a solar output record was hit on February 19th. In our plot here, we have generation and load. We have actual solar and uncurtailed solar in the green, and actual wind and uncurtailed wind in the blue, with net load in the gray. So in this case, irradiance potential was high and that was paired with low wind generation, allowing net load to be relatively high here. And this was enough so that net load did not drop below that 25 gigawatt threshold that we were just looking at. And all conditions were met for a record to be broken at 17.2 gigawatts.

So in contrast, a record was missed a few days later on February 24th, and we can see here that the only criteria that was met was the high potential for solar. So the light green line there represents uncurtailed solar, and it would've been roughly 300 megawatts higher than the record broken on the 19th had it been hit. And looking a little deeper into what's going on here, you'll notice that the wind begins to ramp up in those morning hours where solar begins to stray from its potential as that's happening, and net load drops as a result. And you'll also notice a little bit of curtailment for wind - the difference between the lighter and darker blue lines there - in the later half of the day, but much less than solar curtailment, which is driven primarily by

those differences in tax credits as mentioned a few slides back. So as I mentioned earlier, wind needs to be low for net load to be high, and we can see that the opposite is true here. So as a result, this potential peak on this day that could have been 300 megawatts higher, was missed.

So another important part of this story is the tax implications that I was referencing earlier behind wind and solar generation behind low prices. And so this plot here shows the percent of generation curtailed for wind and solar over the quarter, where solar often has a much larger percentage curtailed than wind. And as we know now, wind tends to elect for the production tax credit, so therefore they will generate even during negative price scenarios. And we can see the February 24th missed record event was due to almost 20% of potential solar generation being curtailed at that time. So it'll be interesting to see if solar projects elect for the production tax credit going forward now that the inflation reduction Act allows for that and how that might change the dynamics in the future. But this is sort of a long term scenario that we won't see show up for a while as this trend is coming out of the recent legislation there.

So bringing back our first plot of solar buildout but now adding in the maximum of uncurtailed solar into the mix as well, we can see the differences between curtailed and uncurtailed records. So over time solar curtailment has grown where solar potential and actual output continue to diverge as prices drop. And at the end of the quarter here, we can see that our record would've been roughly 400 megawatts higher, at 19.1 gigawatts, if it wasn't for the curtailment drivers that we've been diving into.

So lastly, looking at the emissions rate side of things, because that's also a pretty interesting detail, we have a view of Locational Marginal Emissions, or LMEs, as a function of renewable curtailment here. And as we've discussed, during periods of high net load, there's very little renewable curtailment and marginal emissions rates are roughly equivalent to that of natural gas plants. But as net load drops below that threshold and renewables begin to curtail, marginal emissions rates also drop because this curtailment happens when renewables are online, and therefore the overall grid has a lower carbon impact at that time. And this is interesting because this means that these sort of lost emissions impact due to the curtailment and the lost generation is actually relatively small because most of that curtailed energy would've been displacing other clean fuels anyways, rather than fossil generators. So as always with power markets, there's a lot going on behind the headlines of a record-breaking solar output and solar curtailment is something we continue to keep an eye on here at REsurety.

So I'm going to pass off to Carl now to talk about trends in wind and solar generation and value.

**Carl:** Yeah, thanks, Devon, that was great. Yeah, as Devon said, I've got a few slides now looking at overall trends, high level trends, and some of the drivers behind changes in wind and solar value in Q1 2024.

So when we did this same webinar back covering the Q4 2023 period, the story was actually fairly straightforward. On the left hand side here, we see the year over year change in Q4 value for wind across a number of different markets, and we can see that everything is down to a

meaningful extent. And most of that was driven by big changes in average power prices. And that in turn was driven by pretty big changes in natural gas prices. When we look now at the right hand side of the slide here, we're looking at the Q1 year over year changes, and it's a much more mixed story. We see actually ERCOT West wind value is up 25% year over year. While there's a big and meaningful move downwards in wind value in California.

Looking at the same thing for solar, again, it was sort of a consistent picture in Q4 with everything being down meaningfully and in relative alignment across the different markets. We see in Q1 on the right hand side, year over year change is pretty flat for many markets when it comes to solar value. And then there's this, again, large downward movement in solar value in California. And we're going to dig into that as we move through the next few slides.

So first we're just going to look at changes in average power prices. So this, again, is showing year over year changes in Q1, comparing 2023 average power prices to 2024. And again, we see ERCOT West average power prices being up almost 20%. That's being driven by an increase in local load as well as continued challenges around transmission in that part of the grid. It's keeping prices higher. When we look at California, we see this big 60% drop in power prices. We've pulled in here the Henry Hub prices. That's a good indication of natural gas prices across large parts of the country, but it hasn't recently been a good indication of natural gas prices in California. Those prices had stayed higher than the national averages after the 2022 peak. Those have now come down and you'll see that there's been about a 70% drop in natural gas prices in California. And that's a big driver of the change in power prices there too.

So the other component that's driving wind and solar value is the capture rate. This is the ratio of the wind or solar weighted value and those average prices. So it's an indication of how much of those average prices wind or solar projects are able to capture. And we're using hub level prices here, that's something worth keeping in mind. The wind capture rates are fairly stable over time and there's much less of a seasonal variation compared to what we'll see on the next slide for solar. But there is one thing that I wanted to point out here, and that's the highlighted data point in Q1 for 2024. We see for ERCOT West, a reverse in the trend. So there had been a downward trend. Wind capture rates were reducing as more wind was coming online. And now as that solar capacity is increasing, that's helping to move the high prices out into those shoulder and overnight hours. And that's helping to now increase wind capture rates in that market.

Now we're looking at the same chart but for solar capture rates. So we see that bigger seasonal trend with Q2 and Q3 capture rates being much higher than the Q1 and Q4 capture rates. But there's a couple of points here that are worth drawing attention to. First is in ERCOT West, whereas the wind capture rates had been going up in the last couple of years, we see a continued decline in solar capture rates in ERCOT West. And actually the 2024 Q1 capture rate is the lowest that it has been, not just in Q1, but across all quarters. And that's coming off the back of the Q4 capture rate for 2023, which was at that point the lowest too. So as more solar is coming onto the grid in that market, that's reducing the relative value of solar generation. And we'll see more on that in a couple of slides. Second point I wanted to make on this slide is

looking at the capture rates for California. So we've already seen that there's a big drop in the average power prices. We're also seeing that there's a big drop in the capture rate as well for solar in California. So on the next slide we will take a closer look at that.

Here we're looking at the average power prices throughout the day for the entirety of Q1, in both 2023, that's the blue line, and 2024, that's the green line. And this is for SP15 in CAISO. The first thing that stands out is this really, really large drop in average power prices. So the green line sits meaningfully below the blue line, and that's the part of this which is being driven by that drop in natural gas prices. The second thing is that now with prices as low as they are, we see some negative prices. And it's important to stress that what that means is throughout the entire quarter, the average price during the middle of the day at SP15 was negative. And that obviously has a huge impact on solar capture rate. Solar is operating and generating during times when there are significantly lower or even negative average prices compared to the rest of the day.

Now if we dig into some of those trends that we were seeing in ERCOT, we're looking at the same equivalent chart that we were just looking at for California, now West Hub in ERCOT. Again, Q1 year over year prices. 2023 is the blue line. 2024 is the green line. So we don't see that big change on average, they're in much closer alignment on average, although the 2024 prices are slightly higher. And then what we do see is during the day, we see prices that are in much closer alignment, even perhaps slightly lower, in 2024 compared to 2023. While in those shoulder hours and the nighttime hours, those prices are slightly higher. So again, same reason that this is having an impact in California on capture rates. It's a similar driver here. Solar generating during the day is capturing those much lower prices relative to the average throughout the rest of the day. That's also the reason why we're seeing higher capture rates for wind projects in ERCOT West.

So just to round this out and sort of bring it back to the content that Devon was talking about just now, we've added in the net load, the average net load, in Q1 of 2023 and Q1 of 2024 here. And this just helps sort of confirm the hypothesis that the incremental and increased solar capacity and generation on the grid is part of what's driving these lower prices. We can see that the green dashed line is on average higher than the blue dashed line. So net load was higher in 2024 Q1 than 2023 Q1. But during the middle of the day when there's now this incremental solar generation on the grid, we're seeing actually the net load during those hours is pretty closely aligned and maybe even slightly below those 2023 numbers. So when you have a lot of renewables - solar, wind - on the grid, that's keeping prices low and keeping those solar capture rates low as well.

Okay. So that's all the content that we have in terms of the presentation for the webinar. We'll now jump over to some of Q&A. So we have a few questions coming in. Just a reminder to use the Q&A function in Zoom to ask any questions that you have about the content we just covered or anything else in the report.

And to kick us off, I'm going to ask Devon a question that came in about the comment you made related to the different tax credits. So how would we expect solar projects, if they started qualifying and electing for the PTC rather than the ITC, how would we expect that to change some of the dynamics that we were presenting on?

**Devon:** Yeah, I can take that one. So as I mentioned earlier, solar has been sort of historically confined to the investment tax credit. But with the Inflation Reduction Act, solar projects are now able to opt for production tax credit instead, which has been primarily wind until this time, as solar buildout is increasing. So this would change the curtailment dynamic we see today because both wind and solar generators would likely still generate during negative prices, instead of just wind. And it's likely that both wind and solar projects would curtail and be more of a function of region and economic dispatch rather than just fuel types. So it would be definitely interesting to see as that future trend potentially happens.

**Carl:** Perfect. Okay, a few more questions coming in. Thanks for those. So there's a question here about the metrics that we're presenting and whether we're using hub prices or node prices for the wind and solar value metrics.

So that's a really good question. Everything that we're presenting here uses hub prices. The intent there is to show the tradable value and across a large region, it's obviously very important for individual projects how their nodal price compares to that hub price. That nodal price also is in some ways a closer indication of the revenue streams that that project might be receiving, depending on its offtake structures. So yes, everything here is hub, but it's obvious that using nodal prices is an important metric as well. And that's something that we'll take into account maybe in the future reports and webinars as well.

So there was a question about the trend that we're seeing in when the records are set. So it seems like they grow quickly in January, in the earlier part of the year, and then they sort of flatten out through the summer. And the question was, maybe what's driving that?

So my thought there is that there's a desire for those projects, the new projects that are being built, to be online and operational before the summer hits. They want to make the most of those higher prices. They want to be able to capture the maximum value that they can that's expected to occur during those summer months. And so I would expect that the majority of projects that are being developed, there's a target, there's a desire to try and get those online by the end of the year and maybe those start spilling into the first few months of the following year. And then obviously the other component to that is the solar resource is ramping up through those months as well. And so I think a combination of the new projects being commissioned, the solar resource ramping up, is what's driving the big increase in the maximum output of solar in ERCOT during those months. And then it flattens out during the summer because the speed of new commissioning is probably slowing down and also the solar resource potential starts to flatten out and then obviously decrease later in the year.

So there's a question here about how batteries may help change and maybe improve the capture rates that we're seeing in some of these markets where there's a significant increase in solar and renewable capacity.

So my thoughts there, in terms of what impact that will have and will it help sort of save the capture rates, I think it will. And I think we're starting to see that in California now. There's been a lot of media attention and press around some new records being set around battery discharge in some of those markets and that helping to obviously perform energy arbitrage rather than just supporting ancillary markets. And so I think that you have to get to a certain point, there has to be a certain amount of energy arbitrage value for those batteries to start actually behaving in a way that will help those capture rates recover. But I think we're going to start to see more of that in California, especially because there's now a requirement to include storage there with new solar development. And then I think further out, but we'll start to see it in ERCOT as well, the extent to which that shows up and how much storage is showing up compared to the amount of solar that's still being commissioned and how quickly we will see an impact there I think remains to be seen.

So I think that's all we have for questions. So I think that just leaves me to say thank you everyone for joining. Thank you to Devon for the great presentation. And we'll see you next time for the Q2 report and the Q2 webinar. Thanks all.

**Devon:** Thanks everyone.