MARGINAL EMISSIONS RATE – A PRIMER

The following is a brief explanation of the marginal emission rate data posted by PJM. The intention is to help provide a basis for interested parties to understand and use the information. This explanation does not include an in-depth explanation of Locational Marginal Prices or the Energy Markets in general – please consult the Training section of pjm.com for more detailed material on these topics. The explanations presented here are somewhat simplified.

Locational Marginal Price

The Real-Time Energy Market operated by PJM creates Locational Marginal Prices, or LMPs. The LMP represents the price of electricity for a given location at a given time. This price is the result of the costs for operating the generators and other resources on the system, combined with the physical flow of power across the transmission lines. When a given transmission line reaches its capacity, less expensive power cannot always reach a given location. A more expensive generator may be needed to provide power, and this is reflected in the price. In this way, the LMP reflects the price at a location, taking into account the price of generating the power as well as the transmission of the power to the location where it's needed.

More specifically, the LMP represents the cost of generating the next increment of electricity at the location. In other words, if one more watt of power was needed at one spot on the system, the cost of providing the next watt is the LMP. To provide that single watt, a generator somewhere must increase its output. That generator is called the "marginal unit," and reflects the "Marginal" term in "Locational Marginal Price." In some cases when transmission lines are congested, multiple generators may need to increase or decrease their output in order to provide the next watt of power while maintaining balance on the system.

Marginal Units

In general, there is always one marginal unit representing the System Energy Price. When there is congestion on the system, there will be one additional marginal unit for each constrained transmission line on the system. In a system as large as PJM, there is nearly always congestion somewhere on the system, and as a result there are nearly always multiple units "on the margin" – these units are the ones that would be required to change output levels in response to a change in demand.

In simpler terms, marginal units are the units "out on the edge of the supply stack" that determine the price of electricity and would increase or decrease output in response to an increase or decrease in demand. The marginal units are the same at all locations, but the amount of output that each one would change varies by location.

These individual increases and decreases can be thought of as percentages. One marginal unit may have to move up 75% of the new increased demand and another may need to move up 25% of the new demand. In another situation, one marginal unit may have to move up 130%, while another has to reduce by 30% of the increase. The movements will always total 100%, but the amounts vary by location.

Marginal Emissions Rates

The marginal emissions rate for a given location is calculated by multiplying the average emissions rate for the individual marginal unit by the corresponding percentage for that unit. These rates are then added together to create the marginal emissions rate for the given location.

For a location representing a collection of individual locations (such as a transmission zone, or all of PJM), the rates for the locations are averaged together in the same way that LMPs for larger areas are averaged together to form the LMP for the area. (The averages may be simple averages or load-weighted averages, depending on the situation.)

Emissions Rates

The emissions rates used in the calculations are average annual emissions rates (lb/MWh) for each generator. They do not reflect specific rates based on the exact output level of the generator at any given moment in time. For example, differing emissions rates that might apply when a generator is first starting up, compared to when it is at maximum output, are not reflected. PJM uses annual average rates based on public data sources. While there may be some inaccuracy as a result, PJM does not have access to more detailed data.

What the marginal rates mean, and what they don't

In some situations, the marginal units, and hence the marginal emissions rates, can provide an indication of what would happen based on a change in behavior. For example, if a single coal-fired generator were on the margin, and a customer increased their power usage, the generator would need to burn more coal. Likewise if the customer decreased their power usage, the coal generator would burn less coal. In an extremely simple scenario, this is true. The PJM system is vast and dynamic, however, with millions of values changing from one moment to the next. Those changes will be reflected in the dispatch of the next five-minute interval.

It's important to understand that marginal units do not provide a prediction of what *would happen*. They only show what *has just happened.* LMPs for the system are computed every five minutes, and change based on the conditions at the time. Marginal units are a part of this price calculation and they also change every five minutes. The marginal units in one five-minute interval might be completely different from the marginal units in the next five-minute interval. Because of this, marginal units – and the marginal emissions rates based on them –, cannot provide any prediction of the results of an action.

Following the last example, suppose that wind generators are on the margin. A customer might see the low emissions rates and increase their power needs, thinking this is a good time to do so. But the increased demand causes a change in the dispatch patterns, and in the next five-minute interval a coal unit is on the margin, negating the expected benefits. Sometimes this effect can be counterintuitive, and a reduction in electricity use causes an increase in the marginal emissions rates.

While people often think of the generation supply as large groups of resources defined by their fuel type – nuclear, wind, gas, coal, solar, etc. – the reality is that many of these resource types are interwoven with each other. As a result of this, and the constant re-dispatching of the system to meet real-time demands, marginal unit changes cannot be reliably predicted.

Power exchanges with neighboring areas can further complicate this situation. Power flows between PJM and its neighbors (such as NYISO, MISO, etc.), and these transactions also affect power dispatch and can, at times, be marginal. PJM has no detailed information on the generation sources for such imports, and as such, these are considered a zero emissions rate.

Large Positive and Negative Values

As mentioned above, the marginal units are those which will change in output to supply the next increment of power. For the same of clarity in this example, this can be thought of as “one watt”. In order to maintain power balance and prevent transmission overloads, in some cases one marginal unit may need to reduce output while another increases it. In some situations, this can be several times the “one watt” next increment of power. For example, one marginal unit may have to reduce output by 499 watts while another marginal unit raises output by 500 watts.

This can result in unusual marginal emissions rates. If one of the generators in the above example is a fossil unit while the other is a renewable resource (and therefore has a zero emission rate), the resulting marginal emission rate could be a large positive or negative value (depending on which marginal unit was fossil or renewable). These large values are a direct result of the LMP calculations and while appearing counter-intuitive, are correct and expected. Users of the data doing analysis should expect and be prepared for such large positive or negative values.

Marginal Emissions Rates and Compliance

PJM provides this information to help inform stakeholders and policy makers as to the real-time conditions of the system. Because of the various constraints and complexities involved, PJM cannot and does not make any guarantees as to the accuracy of the information nor that it is fit for any purpose. PJM does not support the use of this information by any party to demonstrate compliance with regulatory mandates in any jurisdiction. The information is provided on an as-is basis without warranty of any kind. PJM hereby disclaims any and all liability for claims for any legal, commercial or other consequences that may arise directly or indirectly as a result of the use of or reference to the information provided herein.