DISPLACING CARBON EMISSIONS IN THE POWER SECTOR:

HOW TO MORE THAN DOUBLE EMISSION REDUCTIONS FROM INVESTMENTS IN CLEAN ELECTRIC RESOURCES

Paul Centolella, Mark Gildersleeve, Aleksandr Rudkevich, Ira Shavel, Richard Tabors

The electric power sector will be critical to meeting the Biden Administration's goal of a 50% reduction in U.S. greenhouse gas emissions (GHG) from 2005 levels by 2030. The electric sector accounts for 28% of U.S. GHG emissions. Electrification of transportation and other direct uses of fossil fuels is recognized as a significant component to any plan to reduce national GHG emissions. Electrification will increase electricity demand and make reductions of electric sector carbon emissions even more critical. Making those reductions requires understanding of the operation of the power systems and how investments in renewable energy can have very different impacts on emissions depending on where and when the renewable power generation occurs.

Electric sector carbon emissions have fallen by one-third since 2005, primarily as result of gas-fired and renewable generation displacing coal-fired generation. With limited capacity for storing energy, power system operators must continuously dispatch resources to match demand. Power system operators dispatch resources on a least-cost basis, which means that wind and solar generators, which have almost zero operating costs, are dispatched before fossil fuel generators. As a result, new renewable generation usually displaces fossil fuel generation, lowering electric sector emissions. In addition, a steep decline in U.S. natural gas prices has resulted natural gas generators being dispatched before coal generators in most power systems. The typical new natural gas (combined cycle) generator emits carbon dioxide at a rate that is 57% below that of a coal-fired power plant. Displacing coal with natural gas generation has lowered electric sector carbon dioxide emissions.

Accelerating emission reductions requires looking at the power system as a whole and asking what will be displaced by the addition of new clean energy. The displaced emissions will be those of the generating units whose output is reduced by the addition of new clean resources. What is important is the net change in overall system emissions. We refer to the net change in system-wide emissions per megawatt hour of electricity provided by the new resource as its marginal emission rate. The net change in system-wide emissions depends on the generating units whose output is being changed and will be different depending on where clean electricity is added and the hours in which it is produced. The net reduction in carbon emissions can vary by several hundred per cent from one location to another within a given electric power region and from one hour to another within the same day. Optimizing clean energy investments can often more than double its impact on reducing carbon emissions.

For example, in a given hour the marginal generator in some regions might be a high emitting, coal-fired generator, or, in others, a gas-fired unit with an emission rate less than half that of coal, but still not zero. Alternatively, adding solar in a system that already has a surplus of solar power in certain hours may curtail the output of other renewable resources with no net impact of carbon emissions during hours of peak solar output.

While it may appear difficult to track marginal generators and the displacement of their emissions, this is a calculation that system operators and utilities can readily perform based on their dispatch of generating units. And, with sufficient knowledge of the power system and appropriate models, time- and location-specific marginal emission rates can be reasonably forecast years into the future.

By comparison, just keeping track of power purchased from renewable resources and assuming these purchases reduce emissions at the average system emissions rate or trying to match energy consumption and renewable generation on an hourly basis is economically inefficient and may not lead to fully offsetting the carbon emitted as a result of an organization's electricity consumption.

If the goal of energy purchasers or public policy is to reduce emissions, the most effective strategy is to purchase and use electricity in locations and at times when marginal emission rates are low and to invest in new renewable or clean generation that will deliver power into the power grid in locations where and at times when marginal emission rates are high.

Why isn't this approach being taken by large consumers, or governmental entities focused on reaching carbon neutrality or reducing net emissions? The answer is that locational marginal emission rates are not yet being calculated and posted by power system operators. Such calculations could be readily implemented as an extension of the calculation of Locational Marginal Prices (LMPs) in the organized power markets and marginal power costs calculations in non-market power systems. What is missing is an incentive or directive for operators to calculate these values and make them available to market participants and interested parties. Under its authority over rules affecting rates for the wholesale sale and transmission of power in interstate commerce the Federal Energy Regulatory Commission (FERC) could direct system operators to calculate and publish marginal emission rates.

The calculation and availability of time- and location-specific Marginal Emission Rates and their availability to both corporations and government would help ensure the feasibility, consistency, and economic efficiency of private and public decisions to offset or reduce carbon emissions. Such calculations also could provide a foundation for President Biden's proposed Energy Efficiency and Clean Electricity Standard.

For private corporations seeking to achieve net zero carbon, there would be benefits in terms of auditability, consistency and economics. Evaluating corporate responsibility based on the marginal emission impacts of energy use and clean energy purchases will help satisfy green shareholders and customers as well as competitors who might challenge the accounting for tons of carbon. Consistency is provided by an approved methodology for calculating marginal emission rates that is theoretically correct, measurable, reproducible, and could grow to become an international standard. From a corporate perspective, the economics are critical. Identifying opportunities for investment in renewables would be driven by a probabilistically forecastable value for the carbon reducing investment. The result is that the corporate entity can find those investments that provide the greatest carbon displacement value per dollar of investment.

For government entities seeking to achieve emission reductions and eventual carbon neutrality, the Marginal Emission Rate calculation provides auditable information on the value of current and alternative future investments in clean electric technologies expressed in a reduction in tons of electric system emissions. The calculation of net emission reductions provides one step in understanding how investments can provide societal benefits.

Finally, the calculation and publication of marginal emission rates associated with the real-time operation and dispatch of power systems would be a first step toward the development of an effective Federal Energy Efficiency and Clean Electricity Standard. It would enable government authorities to track the actual emission impacts of efficiency and clean electricity investments made in compliance with the standard. If a federal agency awarding or purchasing clean energy credits decided to incentivize investments by basing credits on approved forecasts on expected reductions in emissions, the calculation of real-time marginal emission rates could enable the implementation of the standard to remain on track to meet long-term emission targets.

The Biden Administration's objectives are ambitious. So are those of corporations seeking to become carbon neutral. The most efficient and effective way to achieve these objectives will be to publish marginal emission rates and track the electric sector emissions displaced by the development of clean electric resources.