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**Welcome to the Tortoise QuickTake podcast. Thank you for joining us. Today, Tortoise provides a timely update on trending topics in the market.**

Hi, I'm Matt Breidert, senior portfolio manager covering energy transition from our London office. Here is something that might surprise you: Annual carbon emissions from the U.S. power grid have fallen more than 25% in the past fifteen years.

Despite the absence of a national carbon emission policy, and without any Federal 'carbon pricing' mechanism as seen in Europe, and despite hostile political rhetoric against climate change science by the current White House, the U.S. grid continues to become more efficient and is steadily decarbonizing.

The principal source of that benefit is twofold.

First, the U.S. economy has gone on a massive electricity 'diet' - despite being more electrified than ever.

After decades of increases, U.S. electricity demand has remained basically flat for almost two decades - during a period where the U.S. added more than 32 million additional people, its economy grew by \$4 trillion dollars in real terms, where nominal income per capita expanded almost 50%, there was zero aggregate power demand growth. And this despite all the millions of new devices in your house, portable electronics in your hand, which are charging almost ALL the time.

This is a staggering statistic.

From 1950 to 2000, electricity's intensity to GDP growth averaged a factor of .4. And then suddenly it became almost zero.

How did that happen?

A logical place to start looking would be to changes in manufacturing over that period. Indeed the U.S. lost manufacturing capacity and output in the 2000-2009 period, but manufacturing output has actually grown slightly over the past two decades in total. The largest shift in U.S. manufacturing is productivity, measured in output per work-hour, which has risen substantially. Ironically that would suggest potentially *more* power demand rather than less, via automation equipment.

The main contributor to flat power demand growth relates to *efficiency*. And that is thanks both to regulations pushing consumers to use power more wisely, and technological progress allowing improvement in the many ways we use electricity. Advances in lighting, appliances, home insulation, smart metering are but a few of the points of impact on recent efficiency gains. Those advances have the effect of saving the user money through reduced usage - without sacrificing quality or utility.

This underpins one of our major investment themes at Tortoise, which is that 'Electricity Wins.' That these technology-led efficiency gains will continue, which accommodates productivity improvements and allows electricity to take further market share within the broader energy mix, both in the U.S. and elsewhere.

So that explains perhaps why carbon emissions haven't risen within the power sector during economic expansion, but what's behind the meaningful declines?

The major source of those reductions relates to changes in the composition and utilization of power supply resources.

Since 2005, coal - the most emitting of all fossil fuel combustion sources - has lost 20% points of market share in U.S. electricity, down from 50% to now just 30% of total. This has been replaced by two cleaner alternatives: natural gas which emits half the carbon per MWh as coal, and which gained 13% points to 32% of total, and new additions of renewable resources - emission-free solar and wind up 8% points, to now 10% of total today.

As a result of this rapid mix shift change in supply, aggregate emissions from the U.S. power industry in 15 years have fallen a total 27%, from 2.4 billion metric tonnes to 1.75 billion metric tons annually. As a function of GDP, the emission reduction impact is amplified, as the U.S. economy has grown significantly: Carbon emissions in the power industry have fallen 53% since 2005, in terms of tonnes emitted/unit of GDP. This is a pretty damaging statistic to any claim that reducing carbon kills

the economy. To the contrary, these carbon reductions in part relate to productivity and efficiency - things that generally promote economic growth and wealth.

And that's especially good news because the next big lever of carbon emissions reductions – transportation - is setting out for a major, multi-decade shift towards electrification. Each increment of carbon emission progress in the power grid's profile in the years ahead will deliver a larger and larger overall carbon reduction improvement as electric vehicles enter the mix.

So with all this good news on carbon reductions in the electricity sector in the U.S., where and why are global carbon emissions still rising so much? Equally, what types of new actions might be needed to accelerate the pace of emission growth reductions?

The reality is that many countries, in particular China, have been going in the wrong direction in terms of total greenhouse gas emissions over this time period. While overall emissions have fallen across much of the OECD in the past two decades, growth in emissions in emerging economies have exploded. In many cases their economic growth has been fueled by some of the most carbon emission intensive options, in particular coal. It is likely this contrasting emission profile position is yet another symptom of inequities in trade relationships, where environmental policy and regulations may be significantly mismatched versus domestic standards, and which have been exploited to capture market share.

It is therefore probable more forceful policies to accelerate greenhouse gas emissions reductions may come to fore, and potentially as unilateral actions rather than grand treaties as seen in Paris in 2015.

Those actions may manifest themselves in new political outcomes or ever-tightening policy goals of decarbonation, as recently legislated by the UK to achieve net zero greenhouse gas emissions emissions by 2050. Given the disparity in emission trends regionally it's not impossible that greenhouse gas emissions intensity and trade relationships come under increasing scrutiny for action. In short, the world may enter a race to decarbonize their grids to international averages as a means to maintain access to trade and market rights.

Back in the U.S. and thinking about how to accelerate greenhouse gas emissions emission reduction, there remains continued progress in reshaping and decarbonizing the power grid, with record additions of new renewable power generation in 2018 and further growth expected in the decade ahead.

Because of the massive declines in cost of wind and solar per unit of output, with new-build construction costs down 80%+ in a decade, and now lower than many of the prevailing incumbent technologies. And equally the significant disinflationary force of hydraulic fracking on natural gas prices, it is currently economically feasible to phase out the entire U.S. coal fleet, replacing those resources with renewables and natural gas-fired baseload power. All with little to no 'cost of service' to end consumers.

It's a paradox, but in effect with enormous capital deployment into these lower cost resources with 20+ year lives and prevailing low interest rates, the resulting cost of service can actually *decline* marginally—while also reducing carbon emissions by 75% for each unit of coal retired.

Utilities across America are waking up to this 'low cost/low carbon' opportunity and implementing programs to accelerate this shift. Equally large industrial and commercial users of electricity are themselves directly sourcing new renewable power, reducing industrial loads for utilities in some cases.

Even in energy-producing Alberta, the provincial government has recognized this dynamic and has now committed to a program phasing out 100% of its coal power by 2030.

The bottom line is there are ample economic incentives to make an even bolder push in decarbonizing the U.S. power grid today thanks to progressively better economics and technology improvements which offer investors a host of attractive investment opportunities as well.

That's it for today. This is just one of a host of topics that we will be covering on the energy transition in the following months.

**Thank you for joining us. And stay tuned for our next cast. Have topics you want covered or other feedback to share? Write us at [info@tortoiseadvisors.com](mailto:info@tortoiseadvisors.com).**

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