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How renewable solid fuel is an important component of the pathway to a more decarbonized future: Wood pellets as a substitute for coal in power generation

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As the consequences of climate change accelerate and become increasingly costly, policies aimed at controlling carbon dioxide emissions from the combustion of fossil fuels will also accelerate and become increasingly aggressive.

There is a readily available pathway in the power generation sector for lowering carbon emissions. The solution leverages existing large utility-scale coal-fueled power stations by substituting a renewable solid fuel for the coal. This relatively easy to implement fuel switching results in a dramatic lowering of the net carbon emissions per megawatt-hour of power generated. The replacement solid fuel is sustainably sourced wood pellets.

This topic has been the subject of previous FutureMetrics white papers. However, given the current covid-19 induced disruption to our global economy and how that may impact energy policy strategies, it is important to remember that there is a relatively low-cost, easy to deploy, and highly carbon beneficial energy source solution for power generation.

Wood pellets produced from renewing working forests are already a major part of renewable power generation in many countries. In the UK, two large coal power stations, Drax and Lynemouth, have been repurposed to use pellets in place of coal. England's largest thermal power plant, Drax, can generate power from 100% pellets on four of its 650 megawatt lines. With relatively low-cost modification, the two converted coal power stations have not lost any output capacity. Each Drax power boiler made 650 MW on coal and they make 650 MW on pellets.

And the power is not intermittent and variable. The chart below shows how power from pellet fuel in the UK performs a baseload role that is impossible for solar and wind. Solar never generates at night and sometimes the wind does not blow very much. Follow the arrow on the chart for an example of a time in the UK when solar (it was nighttime!) and wind were not producing much power. A few days later, wind was producing a lot of power. Pellets, along with nuclear, are stable and underpin the grid's supply of on-demand power. As a benefit to that stability, neither the combustion of pellets nor the energy from nuclear add to the net CO_2 concentrations in the atmosphere.

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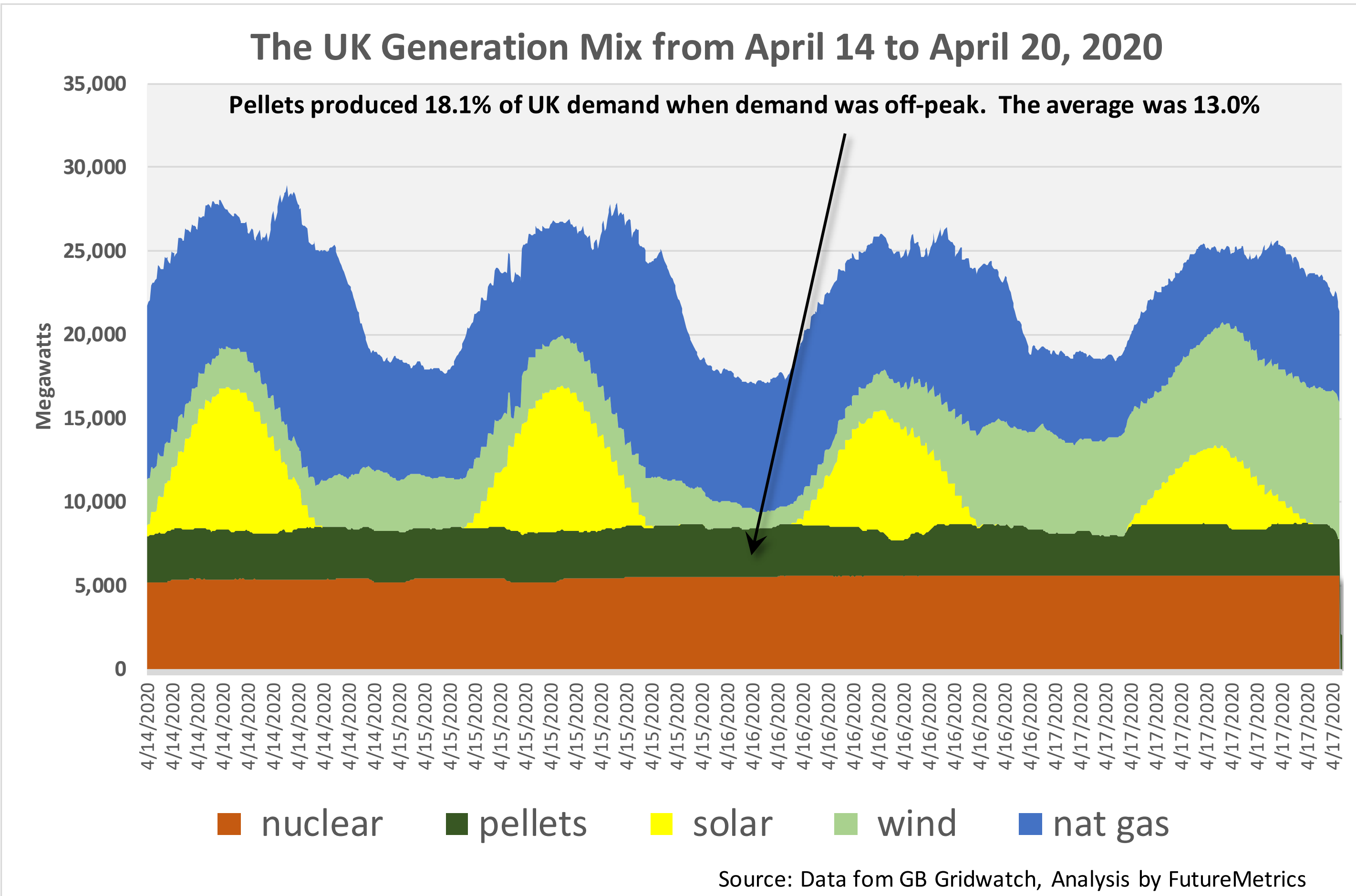


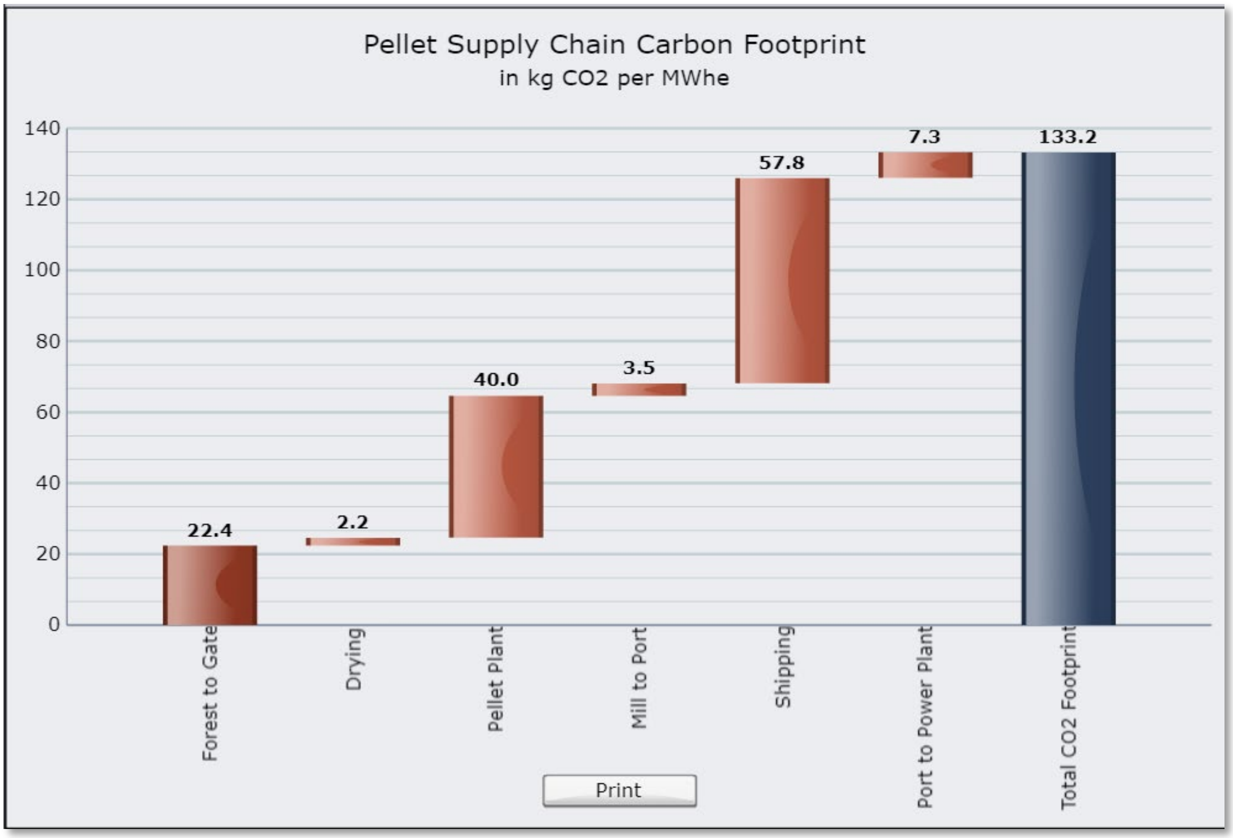
When wind turbines are generating substantial power (from evening April 16 onward in the chart above), less natural gas, a fossil fuel that adds to the net CO_2 in the atmosphere, is used. The baseload from the large power stations running on uranium and pellets provides a steady foundation of low-carbon electricity.

Wood pellets produced from sustainably managed forestry operations, when used to produce power, do not increase the net stock of CO_2 in the atmosphere*. The basic necessary condition for an area of managed forests is if forest growth rate equals or exceeds the harvest rate then the net stock of carbon held in the forest is constant or growing. Thus, the CO_2 released in combustion is contemporaneously absorbed by the new growth and no net new CO_2 is added to the atmosphere: more on this several paragraphs below.

For the Drax power station in the UK, the net reduction in CO_2 emissions from the substitution of pellets for coal averages about 86%. The fossil fuels used in the supply chain for pellets result in a carbon footprint for the pellets delivered to the power station. It should be remembered that the fossil fuels used in the supply chains for natural gas, coal, or diesel also add to the carbon footprint of those fuels. Any fuel that needs to be mined or

* See several earlier free white papers by FutureMetrics on this topic at www.FutureMetrics.com.

harvested, refined, and transported by pipeline, truck, rail, and/or ship will accumulate a carbon footprint if fossil fuels are used for power, heat, and/or transport.



With several assumptions on distances traveled by truck, rail, or ship, fuel used per tonne-km, how electricity is generated, the efficiency of the UK power station using pellets, etc., to get pellets from the southeast US to a power plant in the UK the estimated CO_2 footprint is about 133 kilograms per megawatt-hour of electric power generated (kg/MWhe). The chart above shows how this is calculated[*]. Getting coal to the power station will have a similar CO_2 footprint.

The major difference between pellets and coal is the difference in **CO_2 emissions during combustion**. When a typical grade of coal is used in a typical power station, combustion produces a net of new atmospheric CO_2 of about 980 kg/MWhe.

Pellets produced from sustainably sourced wood fiber produce a net of new atmospheric CO_2 of zero kg/MWhe.

[*] The chart is from a free online dashboard that can be accessed at the FutureMetrics website. The dashboard input assumptions can be changed, and the results update in real time.

Opponents of the use of pellets for power generation disagree with this accounting based on two major objections: (1) pellets are not carbon neutral in combustion, and (2) the use of pellets will lead to deforestation. They are right to be concerned about carbon emissions from power generation and deforestation; but they are wrong about both when it comes to the use of pellets for power in advanced economies.

Pellets are already a major component in the global efforts to reduce carbon dioxide emissions. Those efforts are supported by national policies that in one form or another incentivize the utilities to generate more carbon free power. Those incentives are typically a subsidy to the power generator to offset the higher cost of pellet fuel versus coal. To qualify for the benefits of the policies the generator has to prove with rigorous and independent auditing that there is a net carbon benefit.

The foundation of the auditing is based on a requirement to sustain the net stock of carbon sequestered in the forests. There are many other important criteria for satisfying certification requirements for the use of biomass derived fuel; but here we only focus on how those criteria assure a net carbon benefit.

As a simple example, suppose a managed forested region whose purpose is to grow wood for the forest products industry grows an additional 500,000 metric tonnes of new wood every year. That annual growth rate would set the boundary for the maximum removal in a year. If that boundary is not crossed, then the net stock of carbon held in the forest is not reduced because the net stock of biomass is not reduced. If all of that harvest were to become wood pellets (highly unlikely as sawlogs from which lumber is made almost never turn into pellets) then the carbon released in the combustion of the pellets would be cycled out of the atmosphere by the new growth in the managed forest that same year. Because a significant proportion of the annual harvest turns into lumber and that carbon is not cycled back into the new growth, the net change of CO_2 in the atmosphere is negative as long as the sustainability boundary based on the annual growth rate is not crossed.

This explains why both objections by opponents of using pellet fuel are poorly crafted. We should all be concerned about deforestation. But to use pellets as fuel in a power station in the major importing nations of Europe, the UK, and soon Japan, the pellets must carry credentials certifying that they are produced from sustainable feedstock. If the source of the pellet feedstock is the result of activities that permanently reduce forested land, the power plant will be denied the support that allows it to use pellets in the first place; and those rejected pellets will not have a buyer in those markets. Sustainability rules embedded in CO_2 reduction policies purposefully prevent deforestation.

In general, any large investment in a factory the uses forest products as feedstock, such as a large lumber mill, a pulp and paper mill or a pellet mill, does not expect a factory requiring investments of hundreds of millions of dollars to run short of wood after a few years because their annual demand denudes the forest. For good business reasons, the production rate of a lumber mill, pulp mill, or pellet factory should never exceed the ability of the region to supply wood every day of every year, essentially forever.

In other words, the annual demand cannot exceed the ability of the region to produce annual new growth equal to (or greater than) the mill's annual demand. Matching the size of the mill with the sustainable annual supply is good business.

But pellet producers have to go beyond that "good business" motive because of the requirements for an exporting pellet factory to prove the sustainability of its feedstock. Thus, the fears of deforestation as a result of the pellet business between north America and major pellet importers are unfounded.

The sustainability of the forests translates into the foundation of the carbon benefits of pellets. The sustainability constraint that restricts the annual allowable harvest to not exceed the annual growth prevents the atmosphere from seeing a net increase in CO_2 even if every tree harvested turned into pellets.

But, as noted above, that is not how the industry works. Pellets are not made from the high value portions of the tree. Most of the usable parts of the harvested tree turns into lumber, paper, or other engineered wood products; many of which sequester CO_2. Some by-products from sawmilling turn into pellets; and typically in normal markets, only the parts of the harvested trees that are not suitable for lumber and other building/furniture products, or pulp and paper, turn into pellets.

There is no rational logic that can show that the use of materials from responsibly and sustainably managed forests can result in a net addition of CO_2 to the atmosphere.

As climate change consequences exponentially increase even nations like the United States will see the value in converting some existing high-efficiency coal fueled power stations to use wood pellets.

That strategy avoids stranding some coal power station assets. And the strategy is complimentary to a rational and pragmatic transition to a more decarbonized future by providing renewable reliable baseload on-demand power.

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