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FACT SHEET

MONEY TO BURN II:

SOLAR AND WIND CAN RELIABLY SUPPLY THE UNITED KINGDOM'S NEW ELECTRICITY NEEDS MORE COST-EFFECTIVELY THAN BIOMASS

In 2015, the United Kingdom adopted a program to retire all coal plants by 2025,becoming the first country to commit to a time-bound phase-out of coal.[1] This cornerstone policy is part of the U.K. government's broader commitment to reduce greenhouse gas (GHG) emissions by 80 percent from 1990 levels by 2050. Since then, the costs of clean energy technologies like solar and wind have fallen dramatically—particularly in the offshore wind industry—across European geographies similar to the United Kingdom.[2] Today, a reliable, coal-free electricity grid dominated by truly clean wind and solar energy is not only possible, but is the smart economic choice.

Unfortunately, the United Kingdom has continued to rely heavily on biomass energy to meet its climate and renewables targets, primarily through the conversion of coal plants to burn biomass. These converted coal plants rely on millions of tonnes of imported wood pellets from the Southeastern United States and elsewhere for fuel, and receive billions in taxpayer subsidies.[3] A key reason behind this subsidy program is the U.K. government's erroneous treatment of biomass as a zero-carbon source of electricity at the point of combustion, on par with other renewables like solar and wind.

A new study commissioned by the Natural Resources Defense Council and conducted by Vivid Economics, a London-based consultancy with expertise in U.K. energy systems, concludes that there is no economic or strategic case for coal-to-biomass conversion in the United Kingdom. New economic modelling of the U.K. power system shows that solar and wind can reliably meet the United Kingdom's needs for new electricity capacity—and they can do so more cost-effectively than new biomass, even when the costs of biomass carbon emissions are ignored and the costs of integrating solar and wind into the grid are fully accounted for. According to the findings, existing biomass capacity will be underutilized, and any new biomass capacity will be completely obsolete, within the decade. Continuing to support biomass conversion through a Contract-for-Difference (CfD) could result in the country paying an excess implicit subsidy of over £360 million compared to wind energy.

EUROPEAN RESEARCHERS HAVE BUSTED THE BIOMASS CARBON NEUTRALITY MYTH ONCE AND FOR ALL

Biomass is much less energy dense than coal and other fossil fuels and emits more carbon per unit of generated electricity. Overwhelming scientific evidence from multiple peer-reviewed studies conducted around the world has now debunked the myth of biomass "carbon neutrality," an assumption that currently underlies European renewable energy policy.[4]

In February 2017, the Chatham House issued a seminal report challenging biomass "carbon neutrality." Contrary to industry claims that they only use low-carbon sources of biomass, the report also underscored the conclusions of previous studies, which found that about three-quarters of pellets sourced from the southern United States came from whole trees and other large diameter wood—feedstocks known to be carbon-intensive—while residues accounted for only one-quarter.[5] Three months later, the European Academies Science Advisory Council released a study echoing these conclusions.[6] A report from the United Kingdom's own previous Department of Energy and Climate Change supports these findings, concluding that burning forest-derived biomass from whole trees and other large-diameter wood increases carbon emissions relative to coal and natural gas for decades.[7]

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SOLAR AND WIND CAN MEET THE UNITED KINGDOM'S ELECTRICITY NEEDS—AND CHEAPER THAN BIOMASS

In November 2016, the groundbreaking study *Money to Burn* evaluated the most cost-effective path to ensure reliability of electricity supply and decarbonise the U.K. power system through 2025 when all economic costs are taken into account.[8] The study concluded that in the period 2020–2025, wind and solar are likely to be the least-cost options to achieve these objectives, even after accounting for the costs of integrating solar and wind into the grid.

Replicating the methodology of the original *Money to Burn* study, this 2017 update utilizes a whole-system approach to compare the costs of electricity generation under three different biomass emissions scenarios. This approach factors the latest technology costs, the integration costs of solar and wind power, and the cost of carbon pollution. The Technical Appendix in the full issue brief provides a detailed description of all cost assumptions, biomass emissions scenarios, and Imperial College's *WeSIM* model employed in the study.[9]

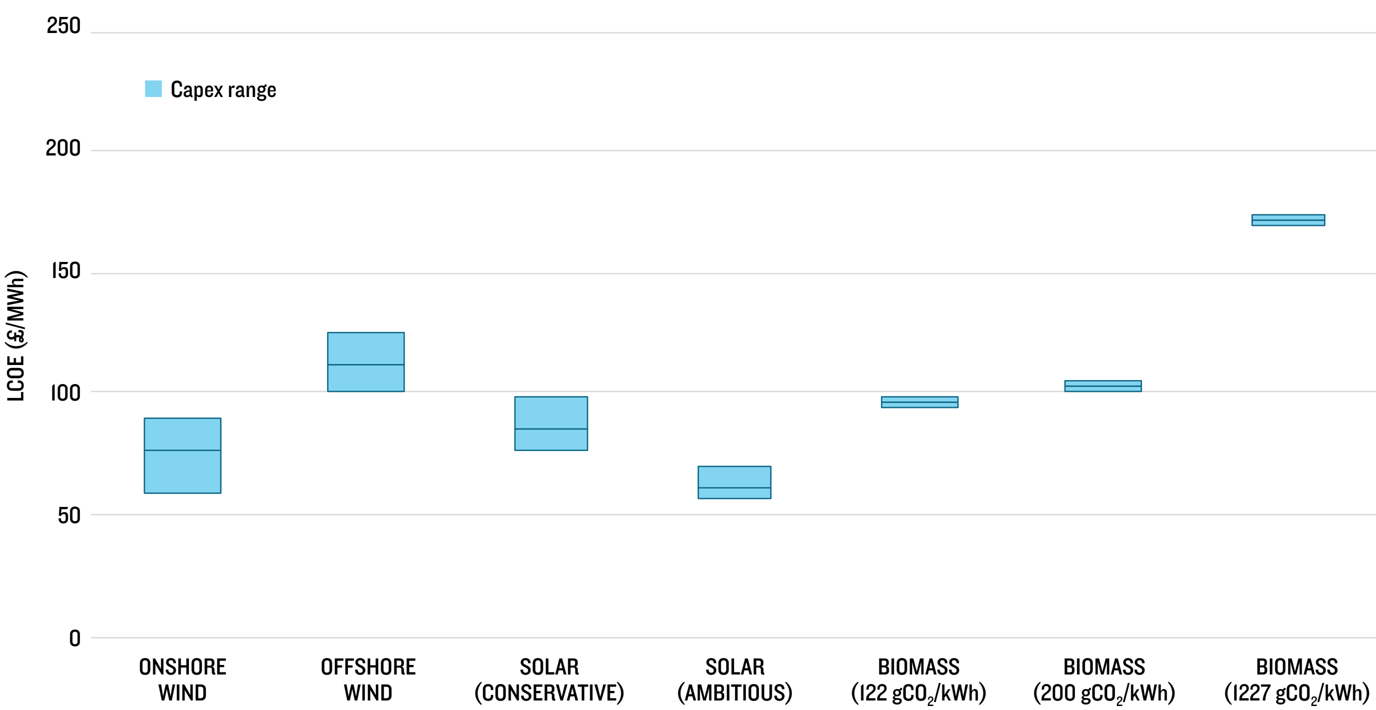
Figure 1 and Figure 2 show the 2020 and 2025 projections for the total economic costs of biomass, wind, and solar under the various scenarios. The economic modelling of the U.K. power sector conducted for this study demonstrates that by 2020, biomass will be higher cost than onshore wind and solar from a total economic cost perspective. In 2025, in all cases, biomass will be higher cost than all forms of wind and solar. Biomass capacity that is already installed will be running at reduced capacity in 2025. This is due to high fuel and carbon costs for these facilities. Instead, it is cheaper to build new solar and wind capacity. These results hold true even for scenarios that do not fully account for biomass carbon emissions and their associated costs.

Biomass will be too costly to meet day-to-day electricity demand, and will also not be able to compete with least-cost options to meet the reliability requirements of the electricity system (i.e. to accommodate peak demand). In 2025, it will be more cost-effective to deploy a combination of wind, solar and natural gas generation to meet the objective of reliability of supply than to deploy biomass generation, even in order to meet demand under a tight carbon constraint. Thus, if new biomass conversions were to be constructed, the modelling indicates that they would become stranded assets—meaning uneconomic to run for any purpose—within the decade.

MORE BIOMASS COULD MEAN HUNDREDS OF MILLIONS IN WASTED TAXPAYER RESOURCES

Vivid Economics conducted additional analysis, based on the economic modelling done for this study, to estimate the impact on U.K. government subsidy expenditures if Drax,

FIGURE 1: TOTAL ECONOMIC COSTS FOR WIND, SOLAR, AND BIOMASS ELECTRICITY GENERATION IN 2020*



*Only capital expenditure (capex) uncertainties explored in Figure 1 and Figure 2. Further uncertainty is possible from projected biomass conversion costs, in particular as it relates to future biomass fuel prices.

operator of the United Kingdom's largest coal plant, received support in the form of a CfD to convert its 4th unit, a 645 MW boiler, to biomass. The company has already converted three of its six units to burn biomass in the form of wood pellets, accounting for 65 percent of its total output.[10]

Vivid found that the total excess implicit subsidy to Drax could be more than £360 million over five years if offshore wind prices are £60/MWh or lower.[11] This includes the wholesale revenues and support payments required to build 645 MW of additional biomass capacity via new coal-to-biomass conversions compared to supplying the equivalent amount of electricity with offshore wind over the five-year period 2023–2027,[12] if these plants had to pay the full costs of operating (e.g. lifecycle carbon emissions and system integration costs).

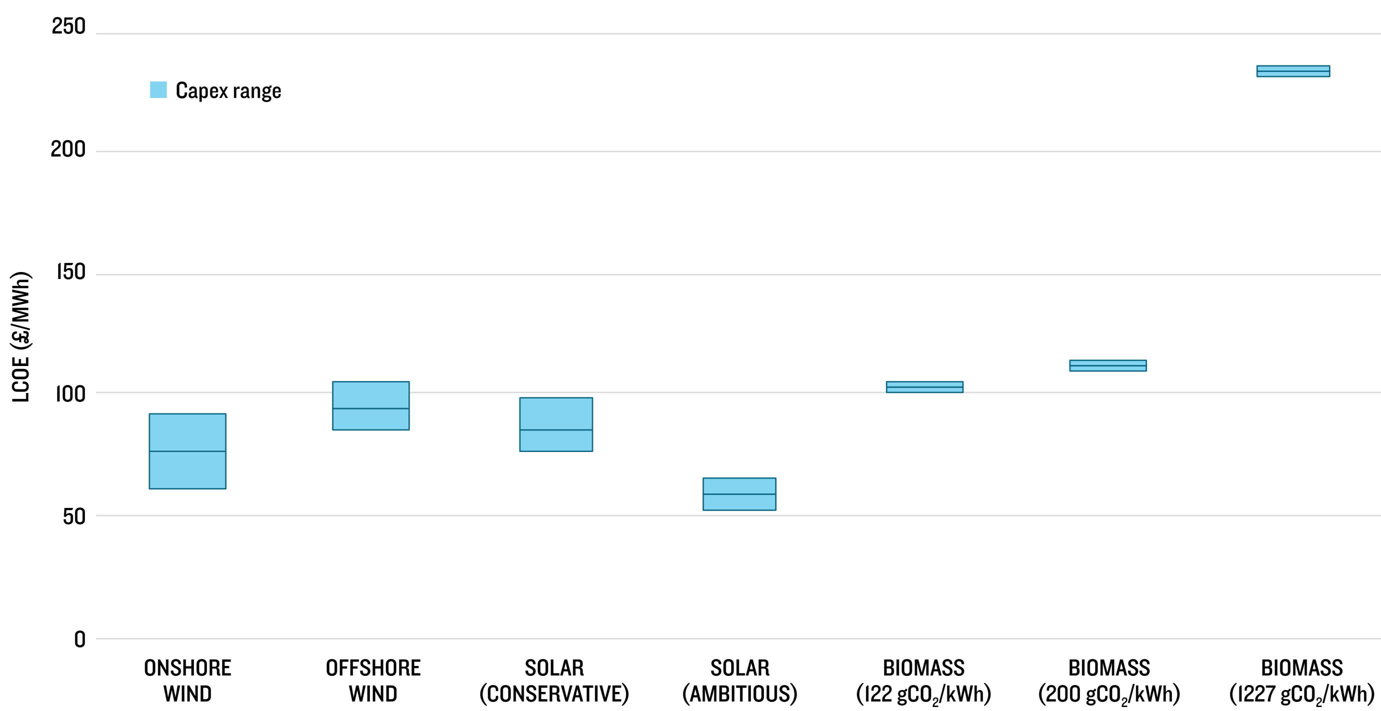
SOLAR AND WIND ARE CLEAN, RELIABLE AND CHEAP; BIOMASS IS DIRTY, EXPENSIVE, AND A DYING INDUSTRY

The analysis indicates that under central levelised technology cost assumptions, biomass is not part of the least-cost technology mix to meet the United Kingdom's affordability, climate change, or electric reliability objectives in 2025, even under significantly underestimated carbon costs. Thus, not only is biomass a dirty form of energy, but any additional subsidies funneled to biomass would be money sunk into a dying industry, rather than invested in the smart, truly clean, and growing renewable energy sector—akin to investing in steam trains in the jet engine era.

There are a number of uncertainties that could impact these results, most notably biomass fuel costs and the rate at which offshore wind costs continue to fall in the United Kingdom. While government assumptions about the levelised cost of biomass conversions were revised down this year, the bulk of biomass costs (approximately 85 percent) remains fuel costs, which forms a floor on potential cost reductions. By contrast, solar and wind offer a strategic investment opportunity; they are already projected to be a more cost-effective replacement for coal in the near-term, and maintain significant scope for additional cost reductions and deployment. Together, they offer the prospect of a truly clean and lower-cost generation mix for the United Kingdom into the future.

To avoid subsidising high-carbon bioenergy and high-risk feedstocks under the guise of 'renewable energy,' U.K. policymakers must follow the science on carbon emissions and acknowledge emerging economic realities. This means immediately ramping down biomass subsidies and shifting investments to truly clean and cost-effective energy solutions.

FIGURE 2: TOTAL ECONOMIC COSTS FOR WIND, SOLAR, AND BIOMASS ELECTRICITY GENERATION IN 2025



ENDNOTES

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4 Colnes, A., et al., Biomass Supply and Carbon Accounting for Southeastern Forests, The Biomass Energy Resource Center, Forest Guild, and Spatial Informatics Group, February 2012, www.biomasscenter.org/images/stories/SE_Carbon_Study_FINAL_2-6-12.pdf. Harmon, M., Impacts of Thinning on Carbon Stores in the PNW: A Plot Level Analysis, Oregon State University, May 2011. Mitchell, S., M. Harmon, and K. O'Connell, "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production," GCB Bioenergy 4, no. 6 (November 2012): 818-827. Repo, A., et al., "Sustainability of Forest Bioenergy in Europe: Land-use-related Carbon Dioxide Emissions of Forest Harvest Residues," GCB Bioenergy, published online March 2014. Stephenson, A. L., and D. MacKay, Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK, U.K. Department of Energy and Climate Change, July 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf. Ter-Mikaelian, M., et al., "Carbon Debt Repayment or Carbon Sequestration Parity? Lessons from a Forest Bioenergy Case Study in Ontario, Canada," GCB Bioenergy, published online May 2014. Walker, T., et al., Biomass Sustainability and Carbon Policy Study, Manomet Center for Conservation Sciences, June 2010, www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-full-hirez.pdf.

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7 Stephenson, A. L., and D. MacKay, Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK, U.K. Department of Energy and Climate Change, July 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf.

8 "Money to Burn? The U.K. Needs to Dump Biomass and Replace its Coal Plants With Truly Clean Energy," NRDC Issue Brief, November 2016, https://www.nrdc.org/sites/default/files/uk-biomass-replace-coal-clean-energy-ib.pdf.

9 The *WeSIM* model has been peer reviewed and validated. The model is published here: Teng, F., V. Trovato, and G. Strbac, "Stochastic Scheduling with Inertia-Dependent Fast Frequency Response Requirements," IEEE Transactions on Power Systems 31 (2016): 1557-1566.

10 Drax Group plc, Smart Energy Solutions, Annual report and accounts 2016, https://www.drax.com/wp-content/uploads/2017/03/Drax-Group-plc-annual-report-and-accounts-2016-Smart-Energy-Solutions.pdf, pg. 35.

11 This approach to subsidy calculation reflects the gap between consumer prices and economically efficient prices.

12 The current CfD auction round is for projects constructed in 2021/2022 and 2022/2023. Because large projects are typically phased in in ~300 MW blocks, it is unlikely that the full 645 MW of capacity could come online in 2022. Thus, 2023 is the first year that the United Kingdom could practically install 645 MW of offshore wind at very low cost. An end date of 2027 was chosen because biomass conversions under CfD are subject to an expiry date of 31 March 2027 under current U.K. government policy.