Oxford Smith School of Enterprise and the Environment

# Policy brief

## Britain's energy demand could be met entirely by wind and solar – both practically and economically


## Summary

- A new Oxford Smith School working paper[1] finds Great Britain's (GB) wind and solar resources are more than sufficient to meet all its energy needs, both *practically* and *economically*.
- Wind and solar energy resources have been underestimated globally and in GB, and predominant narratives that renewables are too expensive or impractical are wildly out of date.
- The analysis shows that GB's estimated practical wind and solar energy resources (2,896 TWh/year) are almost ten times current electricity needs (299 TWh/year) and easily exceed even the highest 2050 demand forecasts for all energy (1,500 TWh/year), including scenarios that involve electrification of much of the economy.
- Conservative estimates show that respectively, onshore wind, offshore wind, utility-scale solar, and rooftop solar could provide 206 TWh/year, 2,121 TWh/year, 544 TWh/year, and 25 TWh/year.
- Following decades of dramatic cost declines and technological advances, wind and solar are now the cheapest forms of newbuild electricity generation in the UK.
- Popular works like Sir David MacKay's 2008 ***Sustainable Energy Without the Hot Air***, which previously guided GB policymaking, are out of date and unsuitable for today's discourse.
- Apparent hurdles to the rapid scaling of renewables, including public perception, energy storage and grid infrastructure, can be overcome with proactive planning and appropriate support.
- Three policy recommendations emerge: (1) remove barriers obstructing the development of new solar and wind, including: planning and connection delays, bans on domestic wind, and inadequate transmission infrastructure buildout; (2) continue to incentivise investment in solar and wind with additional location-based price signals to reduce network congestion, while removing explicit and implicit fossil fuel subsidies; and (3) invest in storage solutions, grid upgrades, and grid services.


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## GB wind on its own could meet 2050 energy demand, with little impact to existing land use and seascapes

**Onshore wind (conservatively, 206 TWh/year)**: the analysis estimates that using existing turbine technology (which will only improve over time), a physical footprint of ~0.07% of GB land (170km$^2$) would be required to provide over 200TWh/year of energy. This includes turbine towers, roads, and associated infrastructure. By comparison, 0.9% of English land is used for mining and quarrying.[2] Including the spacing between towers, turbines would be spread over ~5% of British land (on less than one tenth of farms), co-located with existing agriculture.[3]

**Offshore wind (conservatively, 2,121 TWh/year):** making the most of GB's very windy seas, the analysis highlights that nearly all turbines would be located more than 25 miles from shore, with no impact on seascapes. Using existing technology, they could, alone, meet 140% of total GB energy demand in 2050.

## GB solar potential is higher than many perceive

**Despite GB's lower sunshine, solar potential is high and climbing.** Significant technological improvements in solar cell efficiency mean that new GB solar installations in 2023 could generate as much, or more, energy per square meter as some sunny Australian locations in the early 2000s.

**Rooftop solar (25 TWh/year, conservative):** considering only South-facing rooftops in England, on existing buildings, and with only part of each roof being used for panels, 8.3% of the country's roofs could be fitted with solar panels, generating 25 TWh/year.

**Utility scale solar (544 TWh/year, conservative)**: drawing on previous studies[4] that considered constraint factors like sunniness, land type, distance to grid, and slope, 2% of GB land area (4,740km$^2$) is considered for hosting panels. Impacts to existing land use could be reduced by using vacant lands (1% of GB land area) and supporting dual-use "agrivoltaic" systems, where solar is mounted above lower-maintenance crops or grass grown for livestock, with co-benefits including for biodiversity.[5 6]

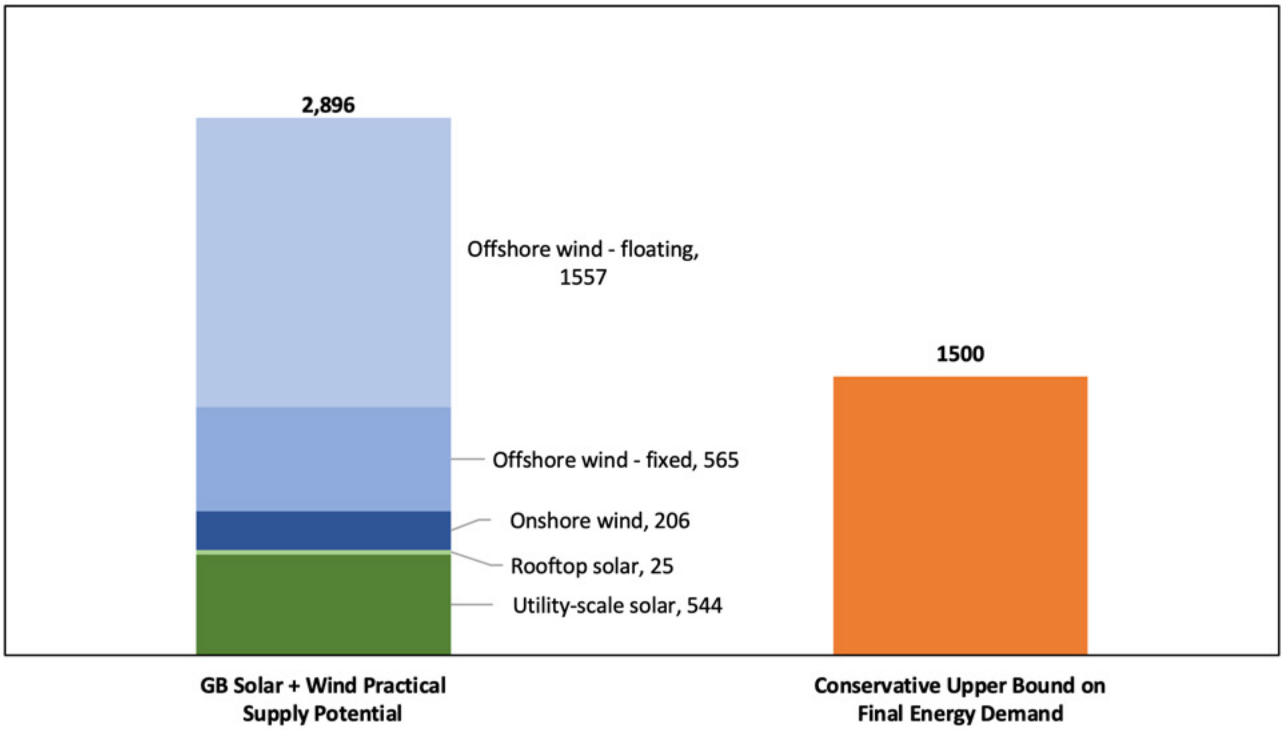


**Figure 1.** Comparison of GB practical supply and total GB Energy Demand (a conservative upper bound on final energy demand in 2050) (TWh/year).
*Source: Authors*

## Many concerns about rapid renewable energy deployment are outdated

**Costs:** though variable renewable energy generation currently incurs additional integration costs, with well-planned investment and proactive policy, alongside rapidly falling storage costs, these costs appear manageable for a high renewable energy future. In recent months, increased financing costs, supply chain constraints, and other global market-based influences, have resulted in an increase in construction costs for some UK installations, notably offshore wind.[7] However, these increases are likely temporary, with long-term costs expected to revert downwards over time. Crucially, the rise in financing costs is not unique to renewables—it impacts non-renewable energy investments as well (sometimes even more so), ensuring that, comparatively, solar and wind remain competitive.

**Public perception**: GB has seen increasing social and political acceptance for mass renewable generation, with 85% of the voting public in favour of renewable energy developments[8] and 89% supportive of further solar projects.[9] Further, wind and solar are now the cheapest forms of newbuild UK electricity generation and there is no reason to suggest public acceptance will not remain high.

**Storage:** costs continue to fall and these trends look set to continue over the coming decades. For example, lithium-ion batteries declined in cost by 79% between 2008 and 2022.[10] [11] A recent report on energy storage from the Royal Society[12] provides useful guidance and examines a wide variety of ways to store surplus electricity—including green hydrogen, advanced compressed air energy storage, ammonia, and heat.

**The grid:** Higher rates of renewable energy penetration benefit from early and sizeable investment in the grid. The 2023 Winser[13] report sets out recommendations to halve the total development time for transmission infrastructure. Furthermore, many grid technologies rely on information processing, electronics, and computing. These are among the fastest improving of all technologies,[14] [15] and their greater use may lead to improved demand-management and overall efficiency.

## References


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**The contents of this Brief and the views expressed solely represent those of the authors and do not necessarily represent those of the Smith School of Enterprise and the Environment, or any other institution. The full paper, which this brief summarises, is available here: Could Britain's energy demand be met entirely by wind and solar? The paper has been reviewed by multiple internal and external referees.**