The implications of landscape visual impact on future highly renewable power systems: a case study for Great Britain

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The decarbonisation of power production is key to achieving the Paris Agreement goal of limiting global mean surface temperature rise to well below 2°C, particularly so given the drive to electricity transport and heat. At the same time, variable renewable energy (VRE) sources such as solar photovoltaics (PV) and wind have seen rapid cost reductions in recent decades bringing them into cost parity with base load fossil generation. Therefore, recent long term planning studies, which utilise cost-optimising models, have demonstrated the important role of VREs in decarbonising power systems across the world. However, while techno-economically detailed, such studies tend to neglect key social factors that often shape the real world evolution of the energy system.

Of particular relevance to VRE deployment is their visual impact on the landscape which can act to undermine their public acceptability. Here, we use crowd-sourced scenicness data to derive spatially explicit, empirically grounded onshore wind energy capacity potentials for three scenarios (Low, Moderate and High) of public sensitivity to this visual impact (see Fig 1). An increasing sensitivity to the visual impact of onshore wind results in a substantial capacity potential reduction, which drives a drop of as much as 89% in the total supply potential of onshore wind per year. We augment these with a detailed analysis of Great Britain's (GB) solar PV capacity potential. We then use these scenarios in a cost-optimising model of GB's power system to assess their impact on the cost and design of the electricity system in 2050. Our results show that the levelised cost of the system can increase by up to 14.2% when public sensitivity to visual impact is high compared to low (See Fig 2). In part this is driven by our finding that some of the most picturesque parts of GB also happen to be the most cost-effective for onshore wind, leading to large reductions in installed capacity as we move through our sensitivity scenarios. Indeed, deployment is heavily limited in Scotland and the South-West which in turn acts to limit the spatial diversity of onshore wind, further increasing system costs. We conclude that it is essential for policy makers to consider these cost implications and to find mechanisms to ameliorate the visual impact of onshore wind in local communities.

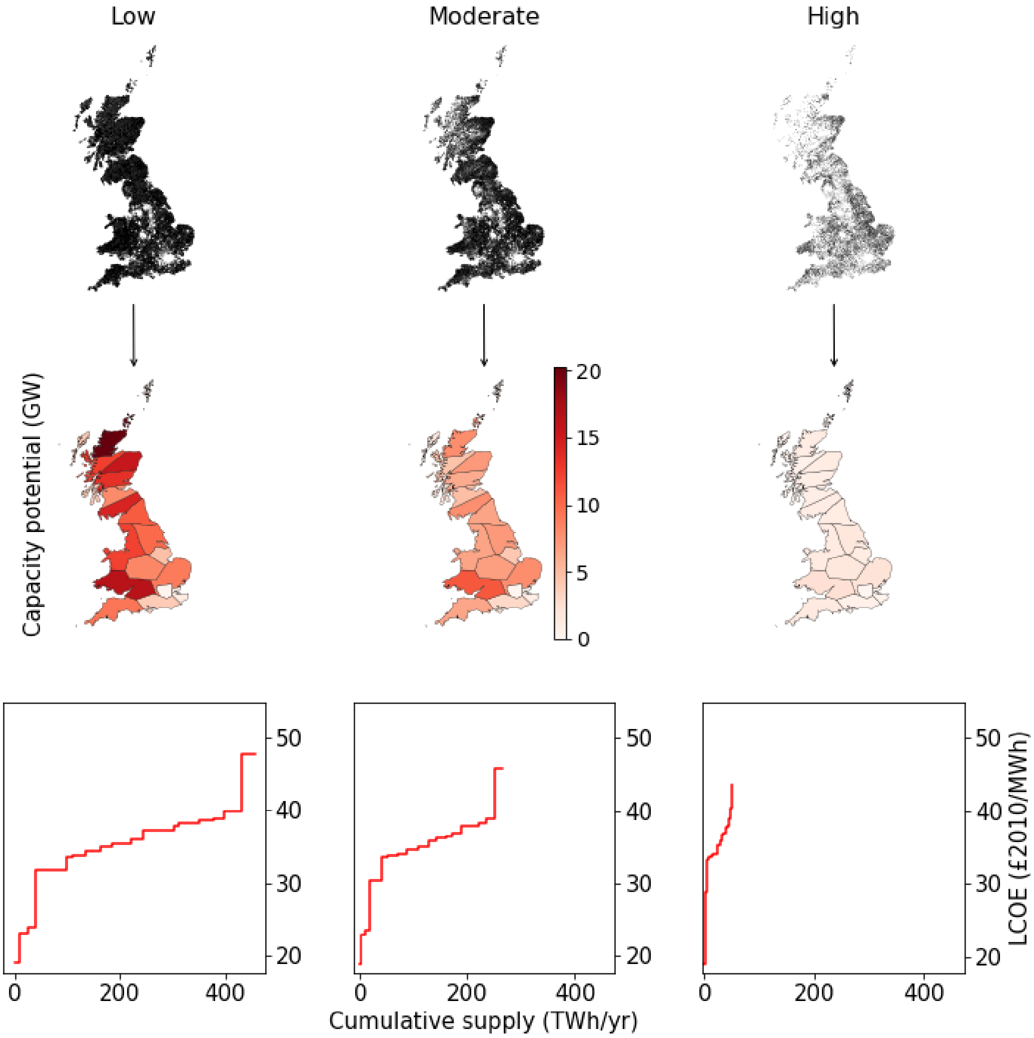

Fig. 1 The impact of the three different visual impact sensitivity scenarios spanned here on capacity potentials and supply curves. In the first row, black areas are land where onshore wind can be deployed. The second row shows the resultant capacity potential (in GW) per zone for the 20 balancing zones in highRES. The available land is aggregated into these zones and then converted to a capacity potential. The third row shows the supply curve for onshore wind with 20 steps, each one corresponding to a zone.

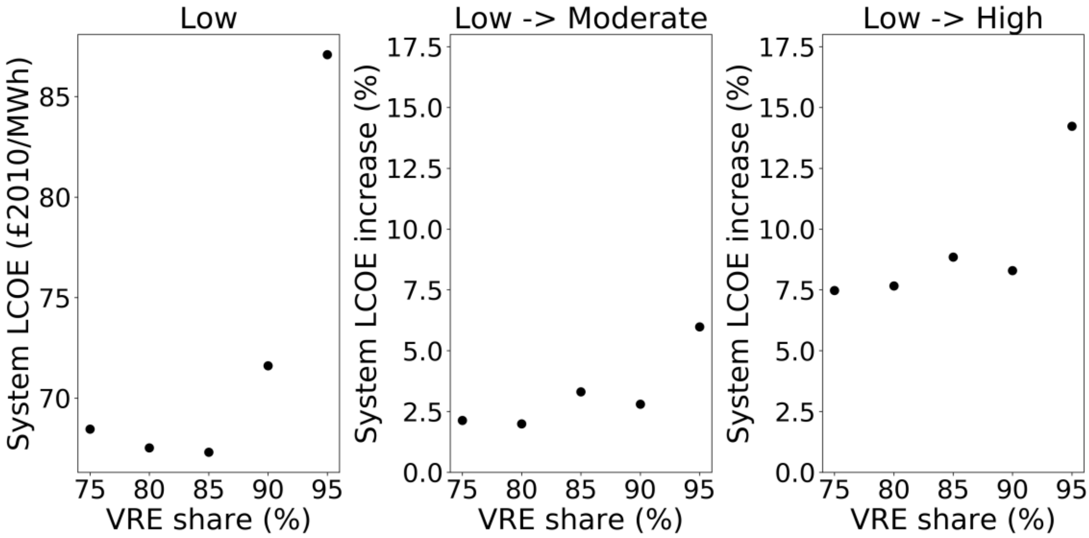

Fig. 2 Total system levelised cost of electricity for our least restrictive sensitivity threshold (left panel) and the change in total system LCOE when moving to the Moderate (middle panel) and High (right panel) scenarios as a function of VRE share in annual generation.