Bigger picture, lower cost

Lowering the cost of the energy transition through a whole system costs approach

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Introduction

The UK Government has identified delivering decarbonisation at the lowest possible cost to consumers as a key part of its energy strategy. To inform its thinking, it has recently commissioned Professor Dieter Helm, CBE to undertake an independent review of costs of energy in the power sector.

This paper argues that a simple way to deliver on the objective of delivering affordable decarbonisation is for government and regulators to better capture the costs and benefits of different low-carbon and renewable energy technologies connected to the electricity grid. A more holistic approach that considers "whole system costs" would drive better value-for-money decisions for consumers. This paper outlines the growing consensus that has emerged in recent years around system costs – or "integration costs" – and proposed practical steps that could be taken to incorporate them into central government market design.

Levelised Cost of Energy vs. Whole System Costs

To reduce carbon emissions, governments around the world are moving away from coal-fired power production. At the same time, the role of variable renewable technologies, such as wind and solar, is increasing dramatically. While these technologies have low or negligible carbon emissions, their increased deployment can represent challenges to maintaining grid security and flexibility. Integrating this broad range of technologies into the electricity grid can result in added costs, which are then passed on to businesses and consumers, including the costs of transmission, balancing, increasing costs to remaining users of the distribution network, financial support schemes and the Capacity Market. To account for all of the costs of a reliable energy system, it is necessary to view the system as a whole, considering the "whole system costs" associated with deploying each low-carbon technology and assigning value to technologies that provide both security and dispatchability.

For years the government has compared the "affordability" of different technologies based on their Levelised Cost of Energy (LCOE) – a simple metric that considers the costs of building, financing, fueling and maintaining an energy project over its lifespan. However, this approach fails to consider the costs associated with maintaining a controllable and flexible energy grid, such as ensuring reliable back-up power, balancing fluctuations in energy demand, maintaining system stability and building new or upgraded transmission lines and cables. These costs are ultimately paid for by consumers and businesses through networking and balancing costs on their bills. These sections of energy bills are not always clear to consumers, but they have been blamed for a significant portion of energy bill increases. One estimate from the National Grid has suggested that balancing costs alone will double between 2015 and 2020 to rise to £2 billion per year.[1]

The Government's Approach to Whole System Costs

By failing to take system costs into account when planning the low-carbon energy system, the government risks making an error that will ultimately cost consumers and business more in the long-run. However, in recent years there has been growing awareness within the government on this issue. In November 2015, then Secretary of State for Energy and Climate Change Amber Rudd MP said in a keynote speech,

> *"In the same way generators should pay the cost of pollution, we also want intermittent generators to be responsible for the pressures they add to the system when the wind does not blow or the sun does not shine. Only when different technologies face their full costs can we achieve a more competitive market."*[2]

More recently, a report commissioned by the Department for Business, Energy, and Industrial Strategy (BEIS), made public earlier this year, also found that LCOE is an outdated metric and states, "there is a growing body of literature that suggests that comparisons on this basis do not capture all the costs and benefits associated with a particular technology."[3] This analysis is supported by a report commissioned by the Committee on Climate Change, which concludes,

> *"System integration costs exist because, when a change in the generation mix occurs, optimal generation dispatch to meet energy demand changes, the generation investment required to maintain a given security standard changes, network infrastructure requirements change, and the requirements for ancillary services change. Hence the LCOE… is not the only consideration government faces when estimating costs of alternative generation mixes. The Imperial [College] modelling estimates these system integration costs… are significantly*

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[1] Gosden, Emily (27 June 2016). *Balancing demand 'could cost National Grid £2bn'*. Daily Telegraph. http://www.telegraph.co.uk/business/2016/06/26/balancing-demand-could-cost-national-grid-2bn/.
[2] Rudd, Amber (November 2015). *Speech on a new direction for UK energy policy.* https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy.
[3] Frontier Economics (March 2017). *Whole power system impacts of electricity generation technologies.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/601345/Whole_Power_System_Impacts_of_Electricity_Generation_Technologies__3_.pdf.

higher for intermittent renewables than other forms of low-carbon generation… Therefore, if the government does not consider the whole system costs that competing technologies impose on the power system, consumers could end up paying more than necessary to achieve the objectives of decarbonisation and security of supply."[4]

The government also demonstrated an evolution in its thinking towards system costs in its "Value for Money Assessment" of Hinkley Point C published earlier this year. In this report, BEIS compared the cost of supporting Hinkley Point C to other technologies, such as onshore wind, offshore wind, and solar on a system costs basis.[5] While a positive step, this does raise the question why this approach is not being taken by government methodically and systematically across all policy-making.

Capturing System Costs in Government Policy

To address this major gap in policy-making, a 2016 study from Aurora Energy Research, a leading UK and German energy market analyst, developed measurement systems to account for gaps not currently assessed by LCOE calculations:[6]

- **Variability** – When weather-dependent renewable technologies are used to produce power, they have less control over their output than dispatchable technologies, which reduces their ability to contribute valuable electricity when electricity is needed. Aurora's analysis adjusts for this by assessing the "capture price" of a given technology relative to the average power price. Higher capture prices indicate that the particular technology is producing valuable electricity during periods of peak demand, e.g. winter afternoons, due to its dispatchability and flexibility. Put simply, they provide services that are more highly valued on the grid.

  The researchers found that capture prices for gas and biomass were above average electricity prices because of their ability to switch on and off easily at times when they are needed. Supply from other technologies is less directly matched to demand, because they sometimes generate more at times when demand is lower, or vice versa. Capture prices reflect a value to the system based on matching supply and demand more or less closely. Aurora argues that this "time of production" value differential between the electricity produced by the different technologies is not considered in LCOE and needs to be accounted for.

- **Security of supply** – To maintain security of supply, notably at times when variable generation is not available, back-up power must always be on hand through

[4] NERA Economic Consulting and Imperial College London (October 2015). *System Integration Costs for Alternative Low Carbon Generation Technologies – Policy Implications: Prepared for the Committee on Climate Change.* https://www.theccc.org.uk/wp-content/uploads/2015/10/NERA-Final-Report-21-Oct-2015.pdf.
[5] Department of Energy and Climate Change (2016). *Hinkley Point C: Value for Money Assessment.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/621400/Detailed_value_for_money_assessment.pdf.
[6] Aurora Energy Research (February 2016). *Comparing costs of renewable technologies.*

mechanisms such as the Capacity Market, which is also paid for by the consumer via energy bills. To adjust for the cost of having an available Capacity Market, Aurora researchers used data from the former Department of Energy and Climate Change to estimate each technology's contribution to security of supply and then charged the cost of the capacity mechanism to each technology accordingly. Their findings indicate dispatchable biomass is significantly more cost effective from a security of supply perspective.

- **Balancing** – Balancing costs are incurred when a technology fails to deliver the output it has committed to with the system operator in advance of actual delivery. Aurora's analysis suggests that biomass (a dispatchable technology) as well as nuclear (a baseload technology) have little or no balancing costs, meeting their commitments more frequently and at times even making money in the balancing market by over-delivering when necessary, which can help to lower associated subsidies. This difference in balancing costs between the different technologies requires a further adjustment to LCOE.

- **Transmission** – Transmission and distribution costs are based on the location of the power generator with the highest costs going to generators located farther away from demand centres. A portion of these costs is passed on to the consumer, but this is not accounted for in LCOE. Aurora's analysis indicates that biomass, nuclear, and gas have lower transmission costs than other renewables because they are often deployed at existing grid connection points.

Aurora's conclusion is that UK contract-for-difference (CfD) strike prices are not directly comparable across technologies because they do not make adjustments to account for the above additional system costs. By evaluating these factors and assigning appropriate handicaps to each energy technology in each category, Aurora's report finds that biomass has the lowest total system costs for any large scale renewable.

Further, a study by NERA Economic Consulting and Imperial College London found that the most cost-effective way to integrate renewable technologies is to have policies and market arrangements in place to account properly for the benefit of flexibility. NERA estimates that if the UK government were to switch to a whole system costs evaluation method for future CfD auctions, it could save consumers around £2 billion over a 15 year period.[7]

Biomass in a Whole System Costs Approach

Biomass is currently the only large scale renewable technology that provides consistent power that is easily dispatchable to meet fluctuations in energy demand and can serve as back-up power generation to balance the grid alongside variable renewables. Without biomass as this

[7] NERA Economic Consulting and Imperial College London (February 2016). *UK Renewable Subsidies and Whole System Costs, The Case for Allowing Biomass Conversion to Compete for a CfD: Prepared for Drax.* http://www.nera.com/content/dam/nera/publications/2016/NERA_Imperial_Feb_2016_Renewable_Subsidies_and_Whole_System_Costs_FINAL_160216.pdf.

back-up, generators must rely on fossil fuels – whether gas, coal, or diesel – to produce on-demand energy. The full cost (both monetary and environmental) of security the grid, ensuring flexibility, and keeping the lights on is not considered.

The focus on LCOE has resulted in some technologies, such as biomass, being seen as relatively more expensive, albeit still a low-cost option among renewables. The benefits of having biomass as part of the renewables mix for grid security and stability purposes have been ignored. If these benefits are accounted for, biomass is even more cost-effective than originally thought.

NERA Economic Consulting estimates that if biomass were allowed to compete in upcoming renewable auctions on a whole system costs basis, it would be the cheapest available technology per MWh. Aurora's research finds similar results, with biomass as the cheapest renewable option when all system costs are accounted for. In addition, both studies find that the flexibility of biomass results in low system integration costs and NERA states, "including biomass as part of the generation mix is likely to lower the costs associated with adding more wind and solar power to the system."[8] Not only is biomass cheaper, it helps facilitate the addition of new renewable technologies to the energy system and helps enable the phase out and closure of coal plants without sacrificing capacity or grid security.

The cost-effectiveness of biomass is underscored by the fact that Drax Power Station, the largest single site renewable electricty generator in the Great Britain, produced 16% of the country's renewable electricity in 2016, with only 10% of the government support paid out to renewable electricity generators. This is based on the output of Drax's biomas units relative to other projects supported under the Renewables Obligation (RO), who receive more support per MWh despite producing less electricity. In fact, last year, Drax's biomass units generated five times more renewable power than the next biggest project supported under the RO.[9]

In addition to its competitive cost, biomass provides significant carbon savings as well. Sustainability data provided over several years by Drax and regulated by the Office of Gas and Electricity Markets (Ofgem) demonstrates that woody biomass can reduce carbon emissions over 80% when used in place of coal to produce electricity.[10] Futhermore, biomass is lower in sulphur, nitrogen, and other harmful pollutants.[11]

There is a large body of peer-reviewed research available on biogenic carbon, including a report published by BEIS earlier this year on carbon emissions in various biomass feedstock scenarios, which agrees that producing electricity from sustainably-sourced, lower-grade wood fibre produces significant carbon savings when compared to fossil fuels. [12] These savings are

[8] NERA Economic Consulting and Imperial College London (February 2016).
[9] Drax (23 March 2017). *More power per pound.* https://www.drax.com/energy-policy/more-power-per-pound/ .
[10] Drax (2017). *Sustainability Reporting*. https://www.drax.com/sustainability/sustainability-reporting.
[11] UK Environment Agency (April 2009). *Minimising greenhouse gas emissions from biomass energy generation.* http://www.globalbioenergy.org/uploads/media/0904_Environment_Agency__Minimising_greenhouse_gas_emissions_from_biomass_energy_generation.pdf.
[12] Ricardo Energy and Environment (2017). *Use of North American woody biomass in UK electricity generation: Assessment of high carbon biomass fuel sourcing scenarios*. https://www.gov.uk/government/publications/use-of-high-carbon-north-american-woody-biomass-in-uk-electricity-generation.

reinforced by the UK's leading Sustainability Criteria for Biomass, which require a cut in emissions of at least 70% compared to the EU Fossil Fuel Grid Average, across the whole biomass supply chain.[13]

Policy Recommendations

Based on the strong body of research behind a whole system costs approach, the government should support an energy price calculation that accounts for the various impacts of a given technology on the energy system and values the benefits of dispatchable energy sources for grid stability and security. Using a whole system costs approach will ensure the UK moves forward with the most cost-effective, reliable, clean energy technology mix possible. Additionally, given its comparatively low cost, sustainably-sourced biomass should be allowed to compete for future renewable auctions. The dispatchability and reliability of biomass make it a smart investment.

The following policies support these positions.

- **The UK government should use a whole system costs analysis to evaluate the costs of different energy projects, taking into account intermittency and system integration costs.**

  The current LCOE method fails to show the associated costs and benefits of different technologies on an equal footing and does not account for system costs of decarbonising the energy market. These costs must be accounted for to ensure that energy bills remain low while also achieving decarbonisation goals.

- **BEIS should reform the contract-for-difference (CfD) scheme by creating one "pot" for all renewable technologies, including biomass, and use a full system costs analysis when determining which projects will receive support under the regime. It should also remove the "maxima" on fueled technologies.**

  When evaluating whole system costs, biomass is a very competitive renewable energy source and is currently the only large scale renewable that provides both baseload and dispatchable power. By allowing biomass to compete with other renewable technologies on a level playing field, the government will secure better value outcomes from future CfD auctions.

  Alternatively, support should be allocated proportionally between "controllable" and "intermittent" technologies. This would also deliver better value outcomes while ensuring that the government is commissioning a sufficient level of flexible power required to balance the future low-carbon electricity grid.

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[13] Ofgem (2017). *Biomass sustainability.* https://www.ofgem.gov.uk/environmental-programmes/ro/applicants/biomass-sustainability.

Additionally, the 150 MW ‘maxima’ on fueled technologies in “pot 2” should be removed as it is detrimental to consumers not only because it limits market competition between technologies, but also because it fails to place appropriate value on the flexibility and security offered by the generating plant.

- **BEIS should establish a fixed timeline and budget for contract-for-difference (CfD) auctions beyond 2020.**

  Government policy should be clear and certain to create investor confidence. However, at present there is no clarity on the future of CfD auctions beyond 2020. Committing to additional auctions that enable all technologies to compete will provide greater certainty to technology providers and their supply chains.