Department for
Energy Security
& Net Zero

Impact Assessment for Biomass Power Transitional Options

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Introduction

1. Building on the work set out in Powering up Britain[1], we believe that a transition support mechanism for eligible biomass generators represents an important step within our commitment to deliver on Net Zero 2050 and Carbon Budget 6 (CB6). The transition support mechanism outlined would support the move towards power bioenergy with carbon capture and storage (Power BECCS) which is integral to our ambitions for reaching these targets at speed and scale.

2. We are consulting to support our assessment of whether a transitional support arrangement is appropriate, and if so, how best to design and implement that support mechanism. This Impact Assessment explores our understanding and assessment of the likely impacts and potential costs and benefits of providing transitional support for biomass power plants.

3. An intervention of this type is outside the scope of the Better Regulation Framework (BRF) and therefore an Impact Assessment is not required. The analysis presented in this document is intended to support consultees to engage with our consultation, by supporting an understanding of the likely impacts of the proposed intervention. We invite consultees to provide any views or relevant evidence relating to this Impact Assessment. This includes for example whether we have identified and accurately assessed the full range of relevant impacts of this intervention.

Problem under consideration and rationale for intervention

The role of Power BECCS in meeting climate change targets

4. The UK's pathway to meeting net zero will involve a range of technologies delivering or enabling carbon abatement on timescales consistent with meeting the UK's various climate change targets. The Government's overall policy approach to meeting net zero involves incentivising and enabling markets where possible to identify the right solutions, without pre-determining or guaranteeing a precise mix of technologies to be deployed. Evidence and analysis play a role in informing net zero policy and strategy by identifying potential cost-effective pathways to meet our targets.

5. Our analysis suggests that deployment of Power BECCS – producing electricity from biomass while capturing and storing the emissions released during combustion – is part of a cost-effective pathway to meeting climate change targets. Specifically, analysis undertaken for the Net Zero Strategy suggested Greenhouse Gas Removals (GGRs) may need to contribute up to 23 megatons per year of negative carbon emissions by 2035 to allow the UK to meet climate change targets; Power BECCS could be a major contributing technology for this.[2]

6. Based on current evidence of the Power BECCS project pipeline, the most mature, reliable and cost-effective options for delivering Power BECCS on CB5 and CB6

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[1] Powering up Britain Policy Paper – Gov.uk

[2] Net Zero Strategy: Build Back Greener – Gov.uk

timescales could involve converting existing biomass power plants to operate with carbon capture and storage (CCS), due to the fact that conversion requires less time, cost and engineering effort than building a new Power BECCS plant from scratch. Power BECCS can produce negative emissions, meaning a net removal of CO2 from the atmosphere. Biomass technologies will therefore play a critical role in hard to decarbonise sectors as they are needed to balance the residual emissions. However, due to the availability of the transport and storage network, the working assumption for this consultation is that power BECCS deployment is unlikely to be operational until 2030 onwards.

7. There are limited existing biomass power plants in the UK, all of which currently rely on government support to generate electricity competitively. Some of these arrangements are due to expire in 2027 and the plant operators have indicated that without government support they may be forced to close or repurpose their plants.

8. Our internal analysis confirms that in most plausible market scenarios, biomass generators would not be incentivised to generate on a merchant basis. If the plants were to close or be repurposed, this could remove the option to convert them to Power BECCS in the future, this would narrow the range of technologies capable of delivering carbon abatement that would support climate change targets.

The role of biomass generators in the UK’s energy mix

9. In 2022 solid fuel biomass provided 7% of the total UK electricity generation[3]. Assuming the same level of energy demand, in a situation where biomass plants are retired, the generation must be replaced by other generators, interconnection or demand side response to secure the necessary level of electricity supply to meet our reliability standards. Therefore, while the primary purpose of the intervention is to help facilitate the transition to Power BECCS, there are also potential security of supply benefits.

10. There are supply-side factors that may increase the relative importance of reliable and dispatchable power generation to the UK’s energy mix during the expected period of the transition mechanism.

11. We are phasing out GB coal generation by October 2024, and some existing gas and nuclear capacity is expected to reach the end of their natural lifespan by the end of the decade, new generation is being brought on in its place.

12. With an increasing proportion of intermittent renewables on the system, we will need flexible and dispatchable generation to ensure continuous supply. This transition coincides with an estimated increase in the demand for electricity. We anticipate that there could be approximately a 50% increase in demand by 2035, with a doubling by 2050. This is due to the electrification of many industries as part of the UK Government’s net zero strategy.

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[3] Table 6.2 DUKES - https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

13. The retiring of biomass generation assets would place additional supply side pressure on the UK's energy system. Biomass generators currently contribute to firm and flexible, low carbon capacity.

14. This Impact Assessment does not include a detailed assessment of the potential impacts of security of supply issues. This is because the Government has existing policy measures in place that are designed to incentivise sufficient generation capacity to meet the required electricity demand, such as the Capacity Market support mechanism. However, we are mindful of the increase in supply-side pressure that would be caused by the retiring of biomass generation assets, and we address this in paragraphs 51-55.

Policy objective

15. This policy consultation is exploring a range of possible interventions that could facilitate eligible biomass generators in transitioning to Power BECCS. The main policy objective for this intervention is:

    - To help facilitate existing biomass power plants transition to Power BECCS likely to be from 2030 (the working assumption for this consultation for when these plants might convert to Power BECCS, the actual deployment timetable will be determined through the CCUS programme), to support the UK in its achievement of climate change targets.

16. The Government is not prepared to intervene at any cost, and the preferred option must therefore demonstrate Value for Money to taxpayers and consumers.

17. This intervention does not guarantee a transition to Power BECCS or provide a support mechanism for Power BECCS generation. The policy objective is explicitly about retaining the optionality of deploying Power BECCS in the future. The decisions, and therefore associated costs and benefits, for the deployment of Power BECCS are outside of the scope of this intervention.

18. The policy proposals, compared to a counterfactual of 'business as usual' (BAU), would also support the UK's security of supply.

Analytical approach

Defining the policy options

19. For this Impact Assessment, we have grouped the different policy options by their potential impact on the level of electricity generation undertaken by the biomass generators to which this policy is relevant. This is because the level of biomass electricity generation is the key determinant of the wider societal impact of the intervention. Specifically, we distinguish between options which may result in eligible biomass generators generating at:

    a. 'High' or 'baseload' levels, with the assumption that electricity market price signals play a limited role in informing when the plants generate.

   b. ‘Medium, seasonal’ levels, with the assumption that electricity market price signals (e.g., seasonal price differences) play a role in informing when the plants generate.
   c. ‘Low, limited’ levels, with electricity market price signals playing a fundamental role in determining when the plants generate (incentivising them to respond to peak demand)

20. We also assess the option to not intervene (‘business as usual’) (BAU). This serves as the baseline against which the intervention options are assessed. In the BAU option, we assume that existing eligible biomass generators cease to generate electricity post 2027. We have used illustrative scenarios (described in the following section) to represent the electricity generation technologies that would replace biomass generation under a BAU scenario.

21. To appraise the policy classes, we have identified the main societal impacts and associated costs and benefits of each policy class. We have then explored the relevant sources of evidence that could be used to assess them quantitatively or qualitatively.

22. Biomass as a generation technology is subject to relatively high current and expected fuel prices, relative to expectations of power prices and other generation income such as the capacity market. As a result, in the absence of support, it is in most scenarios unlikely that large scale biomass plants would be incentivised to generate. This would lead to the potential retirement of the plants and loss of the associated fuel supply chains and logistics.

23. Our options analysis is therefore based on an assumption that, without support, currently eligible biomass plants would not be able to generate enough revenue to cover their average costs through market incentives alone. Consequently, they would likely withdraw from electricity markets.

24. We consider different scenarios for what technology mixes might be expected to replace the equivalent generating capacity and electricity generated by the plants. We have included illustrative load factors for the purposes of this analysis in Table 1 below. These generation profiles do not reflect our specific anticipated level of generation for any of the options but are included as fixed points in a range to generate analysis. This is done to help highlight likely differences in load factor incentives between options.

‘Class’ of policy option	Specific policy options in the consultation document that correspond to this option ‘class’	Assumed nature of generation by existing biomass plants	Net load factor assumption, i.e., % of the year that the plants are incentivised to generate
0	BAU,	No generation	*For illustrative purposes:* 0%
1	Regulated margin, Contract for Difference (CfD) Unconstrained,	High/baseload generation	*For illustrative purposes:* 70% to 90%

2	CfD generation collar, Regulated margin	Medium/seasonal generation	*For illustrative purposes:* 30% to 60%
3	Bilateral availability payment,	Low/peak response generation	*For illustrative purposes:* 10% to 20%

Table 1: The definition of policy classes for this Impact Assessment

**The options that are in each high/mid/low section are based on how we expect eligible generators to be incentivised to generate, but these could be subject to change depending on design and negotiations.*

***A detailed description of each option can be found in the consultation document.*

The counterfactual

25. We have developed a set of illustrative scenarios to model the possible impact on the power sector, by considering what might replace the generating capacity and electricity generated by existing eligible biomass generators in the absence of intervention.

26. We have chosen a simple approach which gives a sense of the trade-offs and scale, which is appropriate for this stage of policy development. This means that wider, dynamic impacts on the power sector are not yet considered.

27. In the event that existing large scale biomass plants cease to participate in electricity markets from 2027 onwards, we consider the following, illustrative scenarios describing how the electricity these plants currently generate would be replaced in table 2.

28. For this Impact Assessment we consider a range of intermittent renewables as part of the energy mix. The technologies considered are Onshore and Offshore wind and large scale solar.

Counterfactual Scenario	Unabated Gas %	Intermittent Renewables %
A	75%	25%
B	50%	50%
C	25%	75%

Table 2: The assumed energy mix of the counterfactual scenarios

29. For this analysis three counterfactual scenarios are considered. Scenario A is replacing biomass with 75% unabated gas and 25% intermittent renewables. Scenarios B is an equal split between intermittent renewables and unabated gas. Scenario C is 25% unabated gas and 75% intermittent renewables. These scenarios cover a wide range of potential deployment possibilities for the more likely combinations of technologies that we anticipate would be displaced by biomass generation.

Key evidence and assumptions

30. We assume that any intervention which secured a continued role for eligible biomass plants would mean displacing the generation and resulting emissions associated with the relevant counterfactual. To quantify the generation related costs in the various

counterfactual scenarios, we rely on standard Department for Energy Security and Net Zero (DESNZ) assumptions for the cost of the relevant electricity generation technologies.[4] To quantify emissions impacts in the counterfactual scenarios, we use a combination of technology specific assumptions from the same underlying source and standard Green Book emissions factors.[5]

Assessment of costs and benefits

Monetised costs

Additional electricity generation costs

Description

31. Based on the Electricity Generation Costs Report 2023[6], there is a higher marginal generation cost of biomass compared to alternative forms of generation such as unabated gas or intermittent renewables. An intervention that incentivises biomass generation would cause the average marginal generation cost to be higher than would have been without intervention.

Methodology

32. Analysis has been produced to understand the possible impacts on additional electricity generation costs in a situation where eligible biomass generators received government support. The analysis is based on three, illustrative scenarios representing different hypothetical levels of electricity generation by the plants to which the policy is relevant. These scenarios are described in Table 1 above. These generation scenarios are compared against the counterfactual scenarios described in Table 2.

33. To assess the potential impact of additional generation costs, we use the following framework:

a. Assumptions

- To assess the potential cost of alternative generating mixes, we use the Electricity Generation Cost Report[7] which provides a comparable unit of measurement across all the technologies considered in the alternative mix. This data set is used to establish a short run marginal cost of generation for each technology. For this analysis we have used biomass price assumptions which reflect our current understanding of biomass market prices.[8]

- We also use the annual generation estimates to understand the cost of producing differing amounts of electricity. We have assumed a level of biomass generation based on the plants expected to be in scope of the eligibility criteria of this intervention.

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[4] https://www.gov.uk/government/publications/electricity-generation-costs-2023
[5] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023
[6] https://www.gov.uk/government/publications/electricity-generation-costs-2023
[7] https://www.gov.uk/government/publications/electricity-generation-costs-2023
[8] Based on DESNZ internal assumptions, this reflects our latest understanding of biomass prices, we will continue to monitor the price of biomass electricity generation for the analysis of this intervention.

b. Calculation: Using the two assumptions detailed above, we can estimate the potential additional cost associated with supporting unabated biomass generation when compared against the different mixes of technologies assumed to represent the counterfactual. To do so, we take the difference between the marginal cost of generating a given amount of electricity with biomass and compare it to the marginal cost of the alternative. This gives the net additional marginal generation costs. See below calculation:

$$\begin{aligned} Impact\ on\ Marginal\ Generation\ Costs \\ &= [S_{Gas}(Annual\ Generation \times Marginal\ Cost_{Gas}) \\ &+ S_{Ren}(Annual\ Generation \times Marginal\ Cost_{Ren})] \\ &- \ (Annual\ Generation \times Marginal\ Cost_{Bio}) \end{aligned}$$

$$whereby: S_{Gas\ or\ Ren}\ is\ the\ share\ of\ the\ generation\ replaced\ by\ gas\ or\ renewables$$

$$Marginal\ Cost_{Gas,Ren,\ \ Bio}\ is\ the\ marginal\ cost\ of\ electricity\ for\ biomass, gas\ or\ renewables$$

34. Table 3 below presents the results of this analysis. The values in this table represent the annual additional marginal costs of electricity generation under the different generation profiles against the counterfactual scenarios. A higher number therefore reflects a greater cost to society of intervention.

Annual additional costs of electricity generation results (2023 prices)

Biomass generation scenario*	**Counterfactual scenario, generation mix that is displaced by biomass generation**		
	75% Unabated Gas, 25% Intermittent Renewables	**50% Unabated Gas, 50% Intermittent Renewables**	**25% Unabated Gas, 75% Intermittent Renewables**
High (70% to 90%)	£1500-£2000m	£1800-£2300m	🟩 £2000-£2500m
Medium (30% to 60%)	£700m-£1300m	🟩 £800m-£1500m	£900m-£1700m
Low (10% to 20%)	🟩 £200m - £400m	£300m - £500m	£300m - £600m

Table 3: Annual additional electricity system costs of generation

**We assume the same market price of biomass for all generation scenarios. There may be variation in the price that generators can secure on biomass fuel stocks given their level of generation.*

🟩 Scenarios which we consider to be more likely

35. The approach taken for this analysis is designed to provide a range of generation cost increases under different scenarios. Our current assessment of renewable deployment suggests it would be difficult to scale up intermittent renewable deployment to the current level of biomass generation in the timeframes considered for this transitional period. Intermittent renewable electricity is already assumed to be near maximum possible deployment during the transition period given the supply constraints in the sector, it is improbable that these constraints could be overcome in the required timeframes to provide power generation at the scale required. Equally, unabated gas plants are expected to play a peaking role in future electricity markets and not run at baseload, therefore situations where unabated gas plants are replacing baseload (high) biomass generation are thought to be unlikely.

36. It is more likely that unabated gas generation is displaced by eligible biomass generators in the low generation scenario. This is due to the role that unabated gas plays as a peaking plant in the electricity mix, where eligible biomass generators are responding to market signals, they are most likely to be incentivised to generate where ordinarily unabated gas would. Conversely, it is more likely that in high generation scenarios, eligible biomass generators are displacing intermittent renewable electricity. This is because intermittent renewables are not dispatchable and have little control over when they are able to provide power. In high generation scenarios there is a greater risk that the power grid has sufficient power and intermittent renewables are forced to switch off.

37. In summary, the analysis in this section suggests that a higher biomass power generation level would increase total marginal electricity generation costs. The more intermittent renewable generation that is displaced by biomass generation, the greater the implied additional total electricity generation costs.

38. These results do not reflect an expectation of the required level of support for the proposed intervention. While any support costs will be heavily dependent on the total costs of generation, the costs presented here are marginal generation costs and are therefore solely the additional economic cost of producing the electricity output of the different scenarios.

39. The analysis in this Impact Assessment relies on our current understanding of biomass and gas market prices. These results are subject to change as biomass and gas prices fluctuate. If gas prices rise relative to biomass, the additional marginal generation cost decreases, favouring biomass as a more cost-effective electricity production method. Conversely, if biomass prices increase relative to gas, the additional marginal generation cost rises. We rely on diverse, up-to-date sources for assumptions on biomass and gas prices. We invite consultees to submit evidence of biomass and gas prices both historical and forecasted.

Non monetised costs

Potential, wider environmental impacts of use of biomass in power generation

40. The Biomass Strategy presented four broad guiding principles[9] that should be considered when considering supporting unabated biomass power generation in the short medium and long term. They should be used along with other relevant factors

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[9] Biomass Strategy 2023.gov.uk

relating to the wider strategic context for biomass use, such as on energy security, an area relevant to the intervention proposed.

41. The four broad guiding principles are:

    a. Sustainability: for the short term (2020s) this requires all biomass uses to be compatible with current and emerging sustainability criteria, including the land and Greenhouse Gas (GHG) requirements.
    b. Air quality impacts: this requires biomass uses to be compatible with regulatory requirements on air quality and compliance with statutory air quality targets and ceilings.
    c. Net Zero Implications: for the short term (2020s) this requires biomass uses to utilise existing infrastructure and planned investments to provide carbon abatement through existing and emerging policy frameworks. Uses should also support the achievement of our longer-term carbon budgets and net zero goals.
    d. Circular economy and resource efficiency. For the short term (2020s) this requires biomass uses to be complaint with the waste hierarchy principles.

42. The Biomass Strategy commits to developing a cross-sector biomass sustainability framework, subject to a consultation in 2024. This will aim to enable greater consistency and to advance the criteria in certain areas. The eligibility criteria for this intervention would give consideration to if and how any sustainability requirements can be updated as this develops.

43. For the support options set out in this consultation, this means, at a minimum compliance with sustainability criteria for electricity generation that is consistent with any existing government funding support received by relevant generators. We will also consider if we can further develop the existing sustainability criteria.

44. Operators under this scheme would operate in line with air quality requirements through the emissions limits that would be set as part of the environmental permitting process. There would therefore be consideration of local air quality impacts when setting emission limits for large biomass combustion plants through environmental permits.

45. Reaching climate change targets such as net zero are one of the key reasons for this intervention. The options considered for this intervention are all expected to retain the optionality of deploying Power BECCS, a technology present in the most efficient pathways to meeting carbon budgets. This intervention is designed to utilise existing infrastructure to provide carbon abatement through existing and emerging policy frameworks.

46. For the circular economy principle, if biogenic waste feedstocks are utilised as the fuel source, it should continue to follow the implementation of the Waste Hierarchy, which operators under this scheme should follow in line with current government (England only) and devolved administration policies and guidance.[10]

Energy supplier collateral costs

47. Some of the options considered for this intervention are variants of the (CfD) framework. For these options, the opportunity cost to energy suppliers would increase as the

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[10] https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

amount of collateral that they would have to post would increase. Additional CfDs in the market would increase the total amount expected to be paid via the interim levy rate (ILR). Energy suppliers are required to post a level of collateral based on their expected payment of the ILR. Posting collateral incurs an opportunity cost as this capital could have been used for other purposes and potentially delivered a return. The opportunity cost is therefore the lost return on the capital that is required to be held for collateral obligations. We have not included our analysis of this cost as to do so would require greater certainty over the policy option.

Monetised benefits

Value of avoided GHG emissions from power generation

Description:

48. Unabated biomass is a low carbon method of producing electricity, with the burning of biomass feedstock categorised as carbon neutral, it is only the transportation and other administrative processes that cause greenhouse gas emissions. Incentivising unabated biomass electricity generation can displace high emission forms of electricity generation. This includes unabated gas and coal. There is a social value to the carbon emissions avoided by displacing high carbon emission power generation.

Methodology

49. To assess the potential impact of these emissions, we use the following framework:

    a. Assumptions: To assess the potential size of emissions that could differ across scenarios, we make a range of key assumptions for all technologies being compared:
       - The emissions intensity for each of the technologies being considered - these are taken from the Greenhouse gas reporting: conversion factors 2023[11];
       - The fuel efficiency (i.e. how much of a given fuel produces a unit of electricity) – this is based on the Generation Cost Report[12].
       - The potential annual generation being replaced - this is based on the suggested generation profiles associated with the scenarios described in Table 1 in this Impact Assessment and the generating capacity of the potential eligible biomass generators.
       - The value of the emissions[13] – this is based on published government estimates for the social carbon value as set out in the Treasury Green Book.

    b. Calculation: The above assumptions are then used in a two-step calculation to estimate the number of emissions for a given scenario, and then estimate the monetary value of these emissions.

       - Step 1: Emissions Estimate. For a given scenario, we use the annual generation, the emissions intensity, and the fuel efficiency multiplier to provide an estimate

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[11] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023

[12] https://www.gov.uk/government/publications/electricity-generation-costs-2023

[13] We have taken the entire social value of carbon cost and removed the carbon cost from the cost of generation to avoid double counting the potential benefit associated with emissions savings from running biomass.

for the emissions associated in a scenario. This is based on either a single counterfactual technology or a generation mix. See below formula for estimation.

$$Annual\ Emissions = Generation\ \times (S_{Gas}[E_{Gas}\ \times F_{Gas}] + S_{Ren}[E_{Ren}])$$

$$whereby{:}\, S_{Gas\ or\ Ren}\ is\ the\ share\ of\ the\ generation\ replaced\ by\ gas\ or\ renewables$$

$$E_{Gas\ or\ Ren}\ is\ the\ emissions\ intensity\ for\ gas\ or\ renewables$$

$$F_{Gas}\ is\ the\ fuel\ efficeincy\ multiplier\ for\ gas$$

- Step 2: Monetary Value of Emissions. For this given mix and emissions estimate, we estimate the monetary value of the emissions that result from replacing the unabated biomass. This is the total social carbon value and includes the carbon cost associated with generation (this has been removed from the marginal costs of additional generation in the earlier section of this Impact Assessment that estimates the impact on generation costs). See below formula for the estimation of the overall policy impact associated with emissions:

$$Policy\ Impact\ from\ Emissions =\ Annual\ Emissions \times Social\ Carbon\ Value$$

Annual social value of greenhouse gas emissions avoided results (2023 prices)

Generation scenario*	**Counterfactual scenario, generation mix that is displaced by biomass generation**		
	75% Unabated Gas, 25% Intermittent Renewables	**50% Unabated Gas, 50% Intermittent Renewables**	**25% Unabated Gas, 75% Intermittent Renewables**
High (70% to 90%)	£1200-£1600m	£800-£1100m	£400-£500m
Medium (30% to 60%)	£500m-£1100m	£400m-£700m	£200m-£400m
Low (10% to 20%)	£200m - £400m	£100m - £200m	£0m - £100m

Table 4: Annual social value of greenhouse gas emissions avoided through biomass electricity production

Scenarios which
we consider to be
more likely

50. For this results table, a positive value indicates a societal gain (i.e. a benefit) due to carbon emissions avoided.

51. The approach taken for this analysis is designed to provide a range of social values from greenhouse gas emissions avoided under different scenarios. The same consideration for the likelihood of each scenario under the additional marginal costs of generation analysis apply to this analysis.

52. In summary, the analysis in this section suggests that a higher biomass power generation level increases the benefits associated with abated greenhouse gas emissions. The more intermittent renewable generation that is displaced, the lower the implied benefit.

Non monetised Benefits

Reduced policy costs of delivering security of supply

Description:

53. Securing power generation outside of existing policies has a potential cost saving to existing policy schemes. This is because securing a guaranteed level of generation from eligible biomass power plants reduces the amount of capacity required in the Capacity Market.

54. The total cost of the Capacity Market support mechanism is:

$$\boldsymbol{Clearing\ price\ (£/kW) * Total\ capacity\ secured\ (Mw)}$$

55. Providing a transitional agreement for eligible biomass generators would reduce the total amount of generating capacity that needs to be secured via the Capacity Market, which means the total cost of Capacity Market support would be reduced.

56. A transitional agreement would also put downward pressure on the clearing price in the Capacity Market auctions. Assuming that there are no changes in the available capacity that bids into the Capacity Market, reducing the capacity required would increase the level of market competition for the remaining capacity. This increases the likelihood that the price setter in the market is cheaper than would have been had additional capacity been required.

57. An estimation of this impact is not included in this Impact Assessment due to the high level of uncertainty of future Capacity Market prices. We also do not wish to set expectations as to the Government’s valuation of future Capacity Market auctions. This could potentially prejudice the bidding patterns of future auctions and result in a worse outcome for consumers.

Potentially avoided additional future energy system costs for meeting Climate Change Targets

58. The primary policy objective of this intervention is retaining the option value of Power BECCS to support meeting climate change targets compared to the next best alternative. Option value refers to the benefits that retaining an option provides. This can be expressed by the increased probability of retaining an option multiplied by the net benefits of the option:

$$\boldsymbol{Option\ value = p(option\ being\ available) * net\ benefit\ of\ the\ option}$$

59. The net benefit of an option is calculated as the benefits minus the costs. The main benefits in both scenarios are the social benefits resulting from reduced and/or removed carbon emissions, a necessity for meeting climate change targets. The costs represent the expenses incurred to meet these emission targets.

60. There are benefits outside of carbon abatement/removal that are present in the pathways to reach climate change targets. However, due to the uncertainty over the scale of these benefits they are not considered in this Impact Assessment. The social value of carbon abatement/removal is therefore the only benefit considered. In both the intervention and counterfactual scenario, it is assumed that the Government meets the climate change targets as these are legally mandated.

61. Greenhouse Gas Removals may need to contribute up to 23 megatons per year of negative carbon emissions by 2035 to allow the UK to meet climate change targets; Power BECCS could be a major contributing technology for this.[14] The next best pathway must remove equal amounts of CO2 or alternatively reduce CO2 emissions to compensate for the lost carbon capture.

62. In the next best scenario, alternative GGRs could be deployed to replace Power BECCS. However, these GGRs are costlier per tonne of captured carbon and have lower confidence in scaling to the required capture levels.[15]

63. With higher costs and lower confidence that GGRs can be deployed at scale both the net benefits of the option and the probability of the option being available are lower. Hence, retaining Power BECCS through this intervention offers an option value advantage over GGRs.

64. There is also consideration for whether additional policy options are available to reduce greenhouse gas emissions. This could include further policy effort beyond current expectations across a range of sectors including, for example: domestic transport, buildings, waste and fluorinated gases (F-gases), agriculture and LULUCF (Land Use, Land-Use Change and Forestry).

65. Existing ambitious policies already influence behaviour, and intensifying efforts would present challenges from a practical perspective, and could potentially increase costs for consumers, businesses, or the government, potentially affecting public expenditure.

66. Achieving carbon reduction at the scale needed to replace Power BECCS through alternative policy options carries a higher risk of unsuccessful delivery. This reduces the probability of option availability of other interventions, causing the next best pathway to have a lower option value.

67. Therefore, it is highly likely that an intervention retaining the option to deploy Power BECCS holds significant option value compared to the counterfactual.

68. Additionally, the eligibility criteria of this intervention are designed to encompass biomass plants that provide optimal value for power BECCS projects, emphasising scale and technological readiness for maximum cost-effectiveness and project deliverability.

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[14] Net Zero Strategy: Build Back Greener – Gov.uk

[15] Greenhouse gas removal methods: technology assessment report – Gov.uk

69. The option value is also tied to the overall probability of successful power BECCS deployment. Retaining eligible biomass generation assets through this intervention preserves the most cost-effective biomass generators and those most likely to transition to power BECCS. This intervention is designed to maximise the value for money and deliverability of Power BECCS projects when decisions on Power BECCS are made.

70. We have not assigned a definitive probability to the impact of this intervention on the marginal likelihood of successful power BECCS deployment; however we are confident that this intervention significantly enhances the likelihood.

Additional power system benefits

71. The retention of eligible biomass generation plants may also have wider power system benefits. Eligible biomass plants currently provide ancillary services to the network, and in a scenario where biomass generators are retired, these services would need to be replaced. Services such as frequency response, voltage control and inertia could all be impacted by the retirement of eligible biomass plants.

72. By retaining the assets, costs of replacing these services would be avoided. An assessment of this benefit is not included in this assessment as it is not currently well understood how different generation scenarios may affect the need to replace these ancillary services. It is likely that in situations where the generation profile is low there would be greater need to replace these ancillary services compared to high generation scenarios. We want to expand our understanding of this and invite consultees to offer their views on the impact on ancillary services.

Cost-benefit summary

73. Table 5 below summarises the costs and benefits considered in this intervention, given the indicative generation scenarios against the BAU option.

Cost or benefit associated with policy intervention		Time period over which the cost or benefit would arise	Group that would realise cost or benefit	Assessment of scale of cost or benefit under policy options (relative to the BAU option) (Per annum)		
				1) High generation Scenario	2) Medium generation scenario	3) Low generation scenario
Costs of intervention	Additional marginal generation costs	During the transition support period, assumed to be 2027-2030+)	Likely to be electricity consumers	£1500m - £2500m based on illustrative scenarios set out in this IA	£700m - £1700m based on illustrative scenarios set out in this IA	£200m - £600m based on illustrative scenarios set out in this IA
	Sustainability impacts of use of biomass in power generation		Various societal groups	We have not monetised this cost under any of the options due to limits of our evidence base and uncertainty around the sustainability impacts in the counterfactual (under a 'BAU' option). We welcome any relevant evidence or views as part of this consultation.		

	Energy supplier collateral costs		Energy Suppliers	We have not monetised this cost as to do so would require greater certainty over the policy option. We welcome any relevant evidence or views as part of this consultation.		
Benefits of intervention	Value of avoided GHG emissions from power generation		Various societal groups	£400m - £1600m based on illustrative scenarios set out in this IA	£200m - £1100m based on illustrative scenarios set out in this IA	£100m - £400m based on illustrative scenarios set out in this IA
	Reduced policy costs of delivering security of supply		Electricity consumers	An estimation of this impact is not included in this Impact Assessment due to the high level of uncertainty over future Capacity Market prices. We welcome any relevant evidence or views as part of this consultation.		
	Option value of deploying Power BECCS	After the transitional support period (from 2030)	The distribution of costs is currently unclear	We have not monetised this potential benefit due to uncertainty surrounding our evidence base. We welcome any relevant evidence or views as part of this consultation.		

Table 5: Cost-benefit summary

74. There are wide ranges in the monetised costs and benefits summaries due to the difficulty in predicting what biomass generation would displace if a transitional support mechanism were agreed. We have used illustrative scenarios to produce the monetised cost and benefit ranges presented in Table 5. We expect to narrow these ranges as the precise nature of policy instruments is determined through negotiations with eligible biomass generators.

75. We also anticipate being able to monetise some of the variables that have not been monetised in this Consultation Stage Impact Assessment as the policy development and evidence base improves.

76. Table 6 below summarises the net monetised cost of the scenarios considered in this Impact Assessment. This gives an indication of the monetised value of each of the proposed scenarios. It is important to note that it has not been possible to monetise all relevant costs and benefits and therefore the figures presented in Table 6 do not provide a comprehensive picture of the net cost of the intervention.

77. There are distributional considerations for the results of this analysis. The costs considered are the additional marginal generation costs while the benefits are the avoided social costs of carbon emissions. Additional marginal generation costs are likely to be passed on directly to consumers. The avoided greenhouse gas emissions are a social cost and not directly experienced by consumers. Net benefits do not account for this distributional impact.

78. It is important to note that the primary policy objective of this intervention is to retain the option of deploying Power BECCS likely to be from 2030. This has the non-monetised

benefit of retaining the option value of Power BECCS against the counterfactual scenario. Therefore, table 6 below provides an incomplete picture of the value of the options considered and is included for illustrative purposes.

Annual Net Benefits (2023 prices)

Generation scenario*	Counterfactual scenario, generation mix that is displaced by biomass generation		
	75% Unabated Gas, 25% Intermittent Renewables	50% Unabated Gas, 50% Intermittent Renewables	25% Unabated Gas, 75% Intermittent Renewables
High (70% to 90%)	£(300m) -£(400m)	£(1000m) -£(1200m)	🟩 £(1600m) -£(2000m)
Medium (30% to 60%)	£(200m) - £(200m)	🟩 £(400m) - £(800m)	£(600m) - £(1300m)
Low (10% to 20%)	🟩 £0m - £(100m)	£(200m) - £(300m)	£(200m) - £(500m)

Table 6: Annual monetised cost-benefit summary £(Negative values)

🟩 Scenarios which we consider to be more likely

79. Table 6 shows that in scenarios where biomass generation is displacing high levels of intermittent renewables there is monetised net loss to society. This is due to the higher costs of generation being greater than the greenhouse gas emissions saved. Conversely, where biomass is displacing unabated gas-powered generation there is a lower monetised net loss to society. This effect is due to the net social benefits that intermittent renewables produce compared to unabated gas.

80. As mentioned above, a negative value in this table may still provide value to society where it retains the optionality of deploying Power BECCS. This is dependent on the relative value that the Government gives to Power BECCS. As the value that government places on the optionality of Power BECCS is commercially sensitive and could weaken the negotiating position of Government in any future commercial negotiation, it is not included in this Impact Assessment.

Public sector equality duty (PSED)

81. We have had due regard to the requirements of the public sector equality duty.

82. Our analysis has considered the impact of this policy on air pollution and the fact that the health impacts of air pollution are worse for people that share certain protected characteristic (the young, the old, pregnant mothers and people with certain disabilities).

There is evidence that people from low-income[16] or ethnic minority backgrounds are more likely to live in areas with higher levels of air pollution. However, there is no evidence to link the air pollution that could result from this policy to such areas.

83. Some options considered for this policy would be levied on consumer bills. It would cost proportionately more for those on lower incomes and so have a negative impact on equality of opportunity for such groups compared to those on higher incomes.

84. This policy aims to mitigate climate change by contributing to negative emissions. Some groups sharing protected characteristics would be impacted more severely and or more commonly by climate change. Thus, mitigating climate change advances equality of opportunity between older and younger generations, different race groups, sexes, and those with and without a disability. The overall assessment is that there would be positive and negative impacts on people with protected characteristics.

Assumptions

85. For our rationale for intervention and analysis we have assumed that the Government meets the climate change targets to which it has committed. These are legally obligated commitments and so it is a reasonable assumption that the Government will ensure it meets them. This is important for establishing the counterfactual scenario where we assume that in the absence of Power BECCS the Government pursues other technologies to meet the climate change targets.

86. We have assumed that all options considered in this intervention would retain the optionality of Power BECCS. As part of the negotiations of any chosen policy intervention the Government would seek guarantees that plants would be ready to adopt the technology when it becomes available. This assumption relies on the Government seeking evidence for these assurances. The option value of the intervention would likely decrease where there is uncertainty that plants would be ready to convert to Power BECCS.

87. We have also assumed that Power BECCS would be ready to be deployed to these plants from 2030. To support the meeting of climate change targets Power BECCS should start scaling in the early 2030s, a delay to this would put pressure on the Government’s ability to reach carbon budgets. This assumption is based on current cluster sequencing analysis. This assumption is explicitly that Power BECCS is available and not a predicted guarantee that Power BECCS would be deployed.

88. An integral assumption to our analysis is that there is a credible risk that biomass generators would retire or repurpose their assets in the absence of government support.

Evidence gaps

89. A large part of the expected costs of intervention are based on the operating costs of biomass generators. The most significant costs for biomass generators are the cost of the biomass fuel stock itself. The supply of biomass pellets has few suppliers. The cost of biomass feedstock is published by companies and forecast by analysis houses.

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[16] While low income is not a protected characteristic, evidence shows that some protected characteristics are disproportionately represented in low-income groups, such as disability, and that there is an uneven distribution of people in relation to race, age and sex other within different income groups.

However, we are aware of the conflict of interest for biomass fuel companies in the reporting of their biomass prices.

90. The Government will be seeking detailed information on the costs of biomass fuel to fully understand operational costs.

91. There is uncertainty over the generation technologies that may be displaced by eligible biomass generators in the intervention scenario. Internal DESNZ models make predictions from which we can base our analysis on. However, this relies on the correct incentives being present in the market to realise the forecasted scenario.

Monitoring and Evaluation

92. The monitoring and evaluation design for this intervention will be defined in the full Impact Assessment, to be published in due course.

This document is available from: www.gov.uk/government/consultations/transitional-support-mechanism-for-large-scale-biomass-electricity-generators