Review of electricity market arrangements (REMA): second consultation

Marine Energy Council (MEC) response

Introduction

The Marine Energy Council (MEC) welcomes the opportunity to respond to the second Review of Electricity Market Arrangements.

A secure and cost-effective transition to net zero requires a diverse energy mix, including technologies which have not yet been deployed at scale. Changes implemented as part of the REMA process need to create the conditions to encourage investment, technical innovation, spread opportunities associated with the growth of renewable deployment, and positions the UK to lead the world in the transition to net zero.

The MEC is the voice of the UK's tidal stream energy (TSE) and wave energy industries. Established in 2018, the MEC's membership spans technology and project developers, key sites, manufacturers, and small and medium sized enterprises working in the supply chain. Our vision is for the marine energy sector to support a secure, cost-effective, and fair transition to net zero, enabling investment, exporting British innovation, and levelling up with employment opportunities across the UK.

Our members are investing in the UK to realise its marine energy potential. TSE and wave energy offer unique benefits that will deliver significant system and energy security benefits:

- **TSE** is entirely predictable and could provide up to 11%[1] of the UK's current electricity demand. This predictability can help reduce supply/demand mismatch in the energy system and reduce dependence on fossil fuels and imports. TSE can be deployed rapidly, with the potential construction time of a consented site being less than three years.
- **Wave energy** provides a more consistent generation profile than solar or wind and could provide up to 20%[2] of the UK's current electricity demand. In addition, its harmonious relationship with wind means it can be co-located at offshore sites supporting a more cost-effective and efficient energy system. [3]

The Contracts for Difference (CfD) scheme has been successful in rapidly increasing the UK's wind and solar energy capacity. However, the focus on Levelised Cost of Energy (LCOE), rather than the value of different energy sources, means the CfD has not yet delivered a diverse supply of renewable generation, jobs have been offshored and potential benefits to the UK missed.

The MEC believes that the REMA process offers an opportunity to change course, and the UK can secure its position as the world leader in constructing, deploying, and exporting renewable technology around the world.

[1] Coles et al (2021) *'A review of the UK and British Channel Islands practical tidal stream energy resource'*. Available online.
[2] Jin et al (2021) '*Wave energy in the UK: Status review and future perspectives'.* Available online.
[3] In this response 'marine energy' refers to tidal stream and wave energy.

Executive Summary

The Marine Energy Council (MEC) agrees with the REMA assessment that without intervention the current electricity market framework will not deliver the secure, clean, low-cost electricity system the UK needs to deliver its net zero ambitions.

The REMA process should prioritise delivery of an energy system with the right capacity and mix of generation technologies and locations to minimise system costs including generation and grid connections, and that is able to manage extreme events. Changes need to enable investment in UK supply chains and green jobs to position households and communities to benefit from the net zero transition.

It is important that in this transition the right lessons are learnt. Many of the issues the consultation raises are unintended, but foreseeable, consequences of the structures and policy mechanisms the UK Government has put in place. We believe the three key issues that need to be addressed are:

The energy system benefit of different renewable technologies needs to be accurately valued in the CfD mechanism *and* electricity market arrangements. *Security of supply*

A key aim of the REMA process is to deliver *'the UK's power sector objectives at the lowest overall system costs.'*

The journey to a cost-effective, secure net zero energy system is not paved by solely deploying the lowest cost renewables today. Research by the University of Edinburgh has shown that deployment of 12GW of wave and tidal stream energy will deliver **£1bn of savings in energy costs** through avoiding the use of expensive peaking generation and energy storage. [4]

The CfD mechanism in its current form does not account for energy system benefit. Issues such as volume risk and herding are not a bug, but a feature of a mechanism with a strong focus on Levelised Cost of Energy (LCOE) over the distinct service that different renewable technologies provide to the energy system. [5]

Improved locational signals will allow marine energy to capture higher costs when there is low wind and solar yield. Tidal stream is entirely predictable. Wave energy is at its strongest over the winter months and can be harnessed several hours after offshore wind generation.[6]

System benefit needs to be a key part of considerations around the future of the CfD mechanism and electricity market arrangements.

Ongoing policy risk and uncertainty is stifling emerging technology development.

Delivery of a renewables-based system requires investor confidence. Currently CfD budgets and ringfences are announced on an annual basis. This does not give emerging technologies sight of a clear and consistent route to market.

[4] Supergen (2023) *What are the UK power system benefits from deployments of wave and tidal stream generation?* Available online.

[5] In our response to the first REMA consultation we recommended that the Government consider moving to an 'enhanced levelised cost of energy' methodology as devised by Frontier Economics and presented by the Business, Energy and Industrial Strategy (BEIS) department in the 2020 *Electricity Generation Costs* report.

[6] Pennock S, Coles DS, Angeloudis A, Bhattacharya S, Jeffrey H (2022) *Temporal complementarity of marine renewables with wind and solar generation: Implications for GB system benefits.* Available online.

A project seeking to bid into the CfD mechanism requires eligible capacity, which is a site that has a lease agreement, marine licence, and a grid offer. Getting these is a costly and time-consuming process. Currently the marine energy industry does not have clarity that there will be a route to market before starting the process. This could be addressed by committing to budgets and ringfences beyond an annual basis or setting clear deployment targets and working with industry on delivery.

The Government should ensure that investor confidence in emerging renewables can be bolstered, and marine energy technologies supported to play a key role in delivering a renewables-based system.

REMA outcomes should position the UK to be a clean energy superpower.

The changes REMA introduce will have a significant impact on the UK's aim to be a renewable energy world-leader. As such the MEC believes the REMA vision is too narrow, and the responses to the challenges set out considered in the context of the UK's net zero journey and ambitions.

The UK is strongly positioned to lead the world in marine energy. For example, the UK is more specialised in tidal stream energy than in other clean technologies, including offshore wind, nuclear.[7] In addition, average returns (on public investments in innovation) in marine renewables is comparatively higher than investment in other renewable technologies.[8]

The UK has an opportunity to seize a global export market, deliver up to £41bn GVA benefit to the UK economy by 2050[9], whilst creating and supporting jobs and supply chains in the UK's coastal communities.

Key points in response to the REMA challenges

Challenge 1 – Passing through the value of a renewables-based system to consumers

- It is imperative that the different services that renewable technologies provide to the UK energy system and economy are accurately valued in the final settlement.
- Co-location of wave and wind, or tidal and BESS provides an opportunity for round-the clock low carbon power. The Government should consider how Corporate Power Purchase Agreements (CPPA) could be incentivised to encourage innovative renewable deployment.
- Without intervention CPPAs will be unlikely to align with REMA's objectives.

Challenge 2 - Investing to create a renewables-based system at pace

- The Government should consider setting multi-year CfD budgets and give advanced sight of ringfenced timelines. This will give confidence to invest in increasing the eligible capacity for innovative Pot 2 technologies to bid into future rounds.
- The current CfD mechanism will not deliver the UK's net zero objectives without significant reform. Too often, as in the case of the Sustainable Industry Reward, reforms are undertaken without consideration of emerging technologies.
- Wave energy has a complementary generation profile to wind, providing more electricity to the system in the winter and strongly aligned with household demand. Tidal stream is entirely predictable and a renewable firm power resource. Currently these attributes are not accurately valued in the energy system.

[7] London School of Economics (2023) *Seizing sustainable growth opportunities from tidal stream energy in the UK.* Available online.
[8] State of Green (2021) *The economic benefits of wind energy*. Available online.
[9] University of Edinburgh (2023) *What is the value of innovative offshore renewable energy deployment to the UK economy.* Available online.

- The MEC supports the Government continuing to consider a deemed generation model for the CfD, however further work is needed to set out exactly how this will function in practice to understand its impact on marine energy growth and deployment.
- Capacity-based CfDs would introduce significant uncertainty for Pot 2 technologies that would not have a clear understanding of the prices they could secure when acting on a merchant basis.
- If the Government introduces a partial payment CfD the level of exposure should vary depending on the technology. A 90-10 or 80-20 split would be more appropriate for marine energy. In addition, under a partial payment CfD the Government should consider extending the duration of the contracts being awarded to increase exposure to market signals whilst giving confidence to invest in renewable energy.

Challenge 3 - Transitioning away from an unabated gas-based system to a flexible, resilient, decarbonised electricity system.

- The Government should not extend incentivisation for unabated gas for flexibility and security of supply purposes. Extending incentivisation will delay the investment in solutions consistent with the aims of REMA and net zero.
- Modelling by Imperial College London has shown that TSE can reduce the UK's required CCGT capacity to meet its energy needs by over 40%, from 8.1GW to 4.9GW.[10]
- The government should be pursuing innovative renewable solutions to support energy security such as pairing tidal stream with battery energy storage to provide renewable baseload energy, and co-locating wave and wind technology.

Challenge 4 – Operating and optimising a renewables-based system cost-effectively.

- Under zonal pricing (with nine zones) we would expect wave and tidal stream energy being able to capture consistently higher prices than wind or solar in every zone. This is due to the offsetting of marine renewable resource with wind and solar, meaning that wave and tidal energy can capture higher prices at times of low wind and solar availability.
- However, the price capture of wave and tidal would be lower in northern zones where the greatest resource exists for marine energy.
- It is critical that the Government sets out its preferred zonal model before any decision is taken forward to allow for thorough industry analysis and consultation. Decisions around boundary changes or the number of zones will have a significant impact on marine energy support for this proposed shift.
- Strong locational TNUoS would be detrimental for the marine energy sector and investment in UK green jobs and supply chains.
- The principle of having separate Pot structures in the CfD to support less established technologies should be applied as the Government moves to increase market signals and exposure for renewable generation.

[10] Frost (2022) Quantifying the benefits of tidal stream energy to the wider UK energy system, available online.

Consultation questions

Challenge 1 – Passing through the value of a renewables-based system to consumers

1. **What growth potential do you consider the CPPA market to have? Please consider: how this market is impacted by the barriers we have outlined (or other barriers), how it might evolve as the grid decarbonises, and how it could be impacted by other REMA options for reforming the CfD and wholesale markets.**

and

2. **How might a larger CPPA market spread the risks and benefits of variable renewable energy across consumers?**

The Government should consider how CPPA's could support innovation and Pot 2 renewables.

We agree with the Government's assessment that Corporate Power Purchase Agreements (CPPA) could have an important, but limited role, in the UK's future energy mix.

In the consultation the government asks how CPPAs could benefit developers of low-carbon capacity. A proposal that could encourage investment in 'Pot 2' technologies could be the creation of an 'Innovation Power Purchase Agreement' mechanism. This would act in the same manner as a CPPA between a generator and customer, but corporate entities could be incentivised to participate through the ability to claim tax benefits. Providing alternative routes to market for emerging technologies will help the UK compete with other countries that offer feed-in-tariffs and other mechanisms.

As noted in the introduction the predictability of tidal stream, and the potential to co-locate wave with wind, would offer consistent generation opportunities throughout the year that may be more closely aligned to the needs of companies entering CPPAs than relying on intermittent renewable resources like wind and solar.

The Government should launch a separate consultation on CPPAs

The MEC recommends that the Government launches a consultation to explore how CPPAs could be utilised to deliver on the UK's broader net zero priorities. It could potentially be a missed opportunity if the Government decides not to intervene or consider how CPPAs could support the UK becoming a world leader in the development and deployment of emerging technologies.

A consultation will provide an opportunity to understand the risks that need to be addressed and what incentives would be required for corporates to support innovative renewables and renewable deployment.

If the government puts in place the right policy mechanisms marine energy can deliver significant economic benefits, and up to £41bn GVA to the economy by 2050.[11]

CPPAs in the future could link benefits to the amount of UK content in the new renewable projects deployed. Tidal stream projects are being delivered with over 80% UK supply chain content spend

[11] University of Edinburgh (2023) *What is the value of innovative offshore renewable energy deployment to the UK economy.* Available online.

and support jobs and green supply chains across the UK. Tidal stream with battery energy storage can provide 100% renewable supply and round the clock demand.

3. **Do you agree with our decision to focus on a cross-cutting approach (including sharper price signals and improving assessment methodologies for valuing power sector benefits) for incentivising electricity demand reduction? Please provide supporting reasoning, including any potential alternative approaches to overcoming the issues we have outlined.**

No response.

Challenge 2 - Investing to create a renewables-based system at pace

4. Have we correctly identified the challenges for the future of the CfD? Please consider whether any challenges are particularly crucial to address.

We agree with the Government's assessment that the CfD will not deliver net zero without reform. There are foreseeable issues such as herding and volume risk that the Government is right to be working to address. It is also not clear that the CfD mechanism is necessarily the best approach for supporting emerging technologies reach maturity.

The Government should consider setting multiyear CfD budgets

It should be noted that renewables like wind and solar were supported through feed-in-tariffs and the Renewables Obligation before the shift to the CfD mechanism. Certainty was critical in supporting mature renewable technologies move down the cost reduction curve.

The Government has demonstrated international leadership in setting ringfences for tidal stream in Allocation Rounds 4,5 and 6. One of the challenges the industry faces is having certainty that the ringfence will continue in the future. This lack of certainty damages investor confidence and is preventing the sector starting the costly process of obtaining a lease agreement, marine licence and grid offer to make new capacity 'eligible'.

One of the key aims of the REMA process is to encourage investment at pace. As long as this uncertainty remains that will be challenging for marine energy. This issue could be addressed through the Government committing to a budget for 3 year periods, rather than on an annual basis; setting a ringfence over a 3 year period rather than on an annual basis; or committing to a long-term deployment target and working with industry on delivery.

Regardless of the CfD mechanism that is decided upon, budgets and ringfences being set on an annual basis is detrimental to the development of emerging technologies.

Reform to the CfD needs to support and enable an increased role for Pot 2 technologies.

The Government is right to set separate pots for different technologies within the CfD mechanism. However, this is insufficient to deliver a diverse energy mix at the pace required. Recent changes for future allocation rounds have been disappointing with narrow scopes, for example, Sustainable Industry Reward is solely focussed on offshore and floating wind. This ignores the significant opportunities in other renewable industries including TSE and wave energy. TSE projects are currently being deployed with upwards of 80% UK supply chain spend.

If the UK Government acts, TSE and wave energy could deliver up to £41bn GVA benefit to the UK economy by 2050.[12] In addition, we know that average returns (on public investments in innovation) in marine energy projects and TSE is comparatively higher than investment in other renewable technologies and strongly supports balanced economic growth.[13]

The SIR's scope means that projects that are delivering significant benefits to the UK will not be supported because they are not floating or fixed offshore wind. The Government should ensure that

[12] University of Edinburgh (2023) *What is the value of innovative offshore renewable energy deployment to the UK economy?* Available online.
[13] Resolution Foundation (2022) *The Economy 2030 Inquiry*. Available online.

emerging technologies and the benefit they can deliver are not overlooked if the existing CfD with reform route is chosen.

5. **Assuming the CfD distortions we have identified are removed, and renewable assets are exposed to the full range of market signals/risks (similar to fully merchant assets), how far would assets alter their behaviour in practice?**

There will be a limit to how marine renewables can respond to market signals. This is particularly true for tidal stream as we know where the resource is located, which is not flexible.

The benefit of interventions encouraging behavioural change needs to be weighed up and considered against a potential increase in the cost of capital caused by interventions which increase uncertainty.

The generation profile of wave energy and tidal stream may become more accurately valued as CfD distortions are removed. Tidal stream is entirely predictable and can be harnessed regardless of whether the wind is blowing or the sun is shining. Longer term there is an opportunity to link the tidal generators with different flow times to produce continuous power. Wave energy is strongly aligned with energy demand, with yield increasing in the winter months when electricity demand increases.

Table 1 - wave energy matched with demand

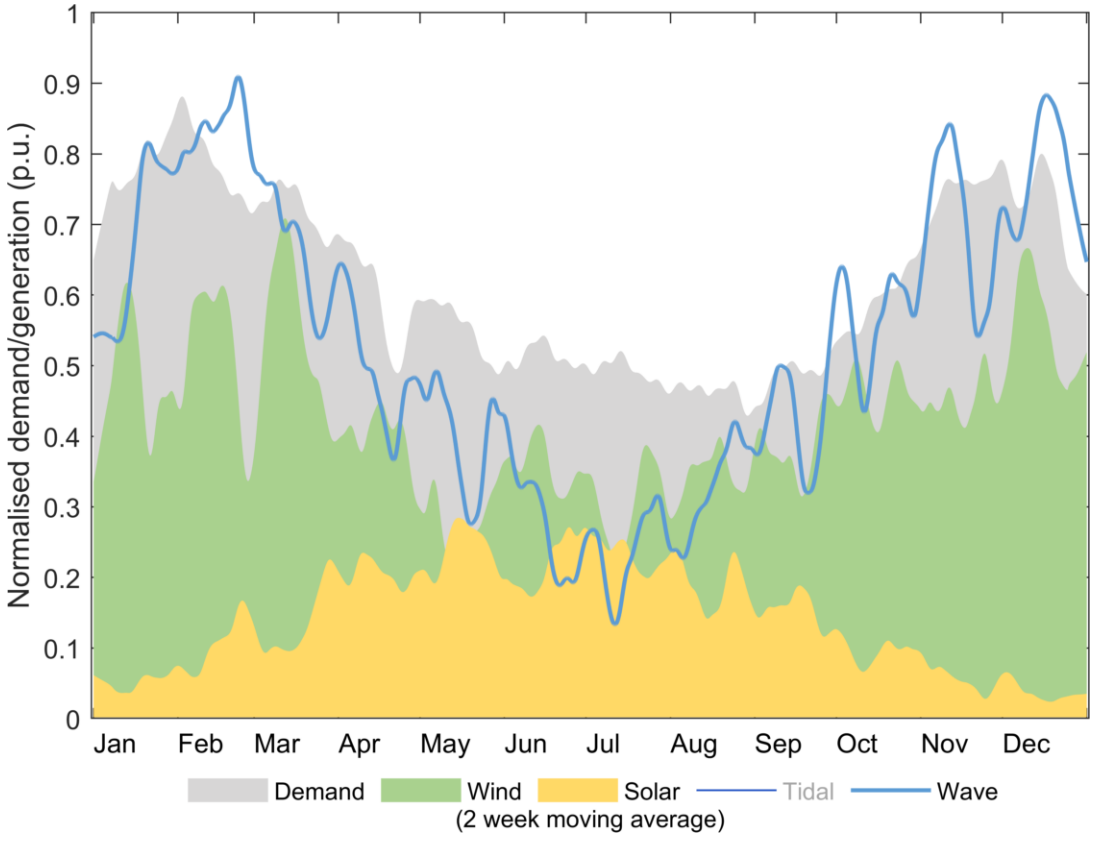
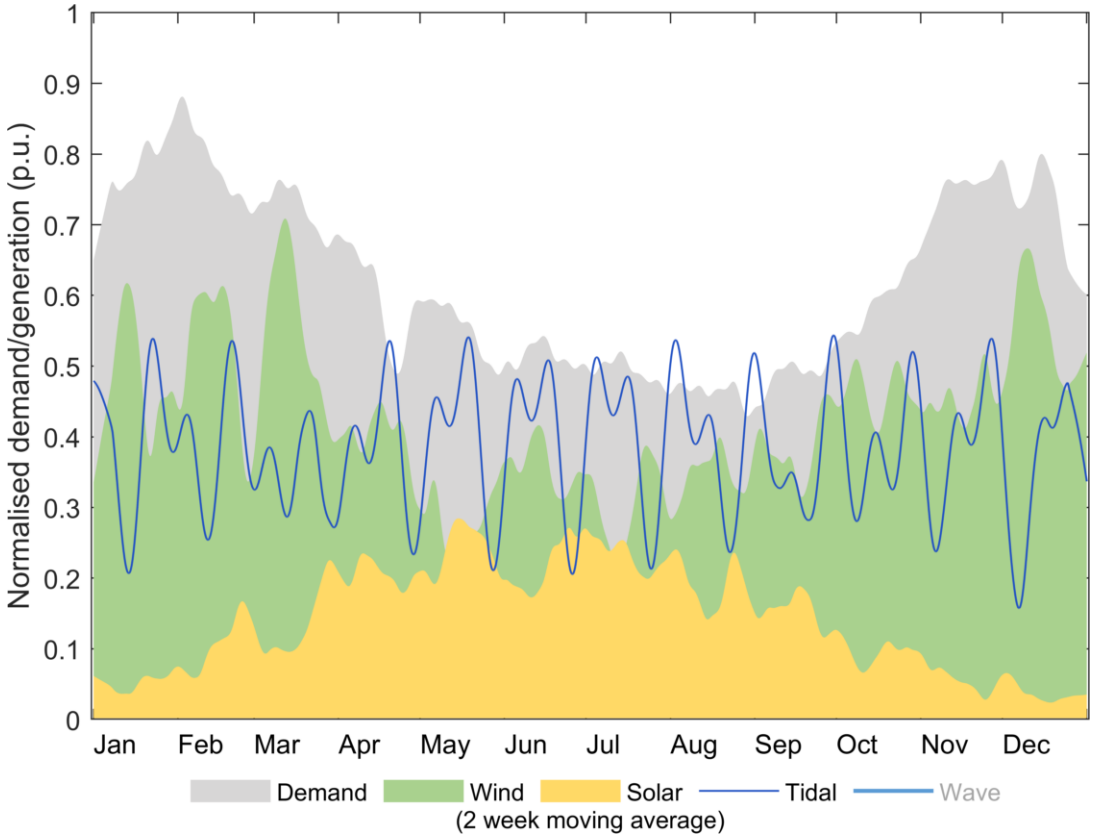


Table 2 - tidal stream energy matched with demand[14]



Increasing exposure to market signals could make innovative renewable deployment more attractive, for example co-locating wave energy converters with offshore wind to take advantage of assets (such as offshore cabling) when there is low wind yield. Co-locating wave and wind energy will deliver a saving of up to 12% in the Levelised Cost of Energy for both projects.[15] The distance between offshore wind turbines can be as much as 1km, providing ample opportunity and space for wave energy converter deployment.[16]

6. How far will proposed 'ongoing' CfD reforms go to resolving the three challenges we have outlined (scaling up investment, maximising responsiveness, and distributing risk)?

The primary challenge for marine energy in the current CfD mechanism is the need to rapidly scale up investment, which is hampered by too much risk being placed on this sector and emerging technologies. The lack of a clear route to market for wave energy, and uncertainty about the continuity of the tidal stream ringfence, is damaging for the development of the UK's marine energy sector.

Often changes, including the ongoing CfD reforms that DESNZ has consulted on (hybrid metering), are undertaken without strong consideration for the impact on Pot 2 technologies, nor ensuring these can access the benefits of interventions like the Sustainable Industry Reward (SIR).

The impact of different reforms will vary from technology to technology. As noted in Appendix 2, the impact of different reforms may favour low Capex projects rather than those which offer best value to

[14] Data for both tables available online here.
[15] Offshore Wind Consultants Ltd (2023) Wave and Floating Wind Energy. Available online.
[16] Economist (2023) *Harnessing wave energy along with offshore wind*. Available online.

the system. The current structure does not accurately value the system benefit that is delivered through a diverse energy mix. Deployment of just over 12GW of wave and tidal stream energy will **save the UK £1bn in energy system cost**. This is due to avoiding expensive peaking generation and storage necessary in a net zero energy system dependent on intermittent renewables.[17]

It is not clear that any of the proposed changes will help address concerns like volume risk and herding. There are increasingly periods where CfDs will not pay projects, and it is critical that tidal stream and wave energy is protected from zero cost as this is adding increased risk for emerging technologies. The risk of curtailment for emerging technologies needs to be addressed if the Government does decide to pursue the current CfD with reforms.

Any changes to the CfD must recognise that a secure transition to net zero requires a diverse energy mix to minimise system costs. The CfD focus on LCOE means that the value of different energy sources is not recognised nor investment in a range of technologies expediated. In addition, a technology's broader value in terms of supporting UK supply chains, creating jobs and export opportunities are not recognised.

For marine energy the challenge is that the CfD does not accurately value the benefit these technologies bring to the energy system or the UK's net zero transition. The proposed changes do not resolve this.

Whilst the CfD remains the primary means of delivering renewable deployment, there is a no clear route to market for wave energy without the introduction of a ringfence. In the absence of a ringfence, it is likely this industry will develop elsewhere, and the UK will miss out on securing first mover benefits.

7. What specific gaming risks, if any, do you see in the deemed generation model, and do any of the deeming methodologies/variations alter those gaming risks? Please provide supporting reasoning.

We support the Government continuing to consider the deemed generation model. However, by decoupling payment from output there is a risk that technologies that are not performing well are overcompensated. In a deemed model, and depending on the option that is pursued, there may be the risk that the model does not accurately capture differences within technologies. For example, for tidal stream alone there is more than one type of device being deployed to harness this predictable resource. The Government may have to introduce a site specific and technology type specific input to capture these differences.

As payments will be based on how much a site could have generated, based on weather data and power curves, there is the risk that this is not accurately measured. Of the four options being considered the fourth would appear to be the best way of avoiding gaming and still maintains payment based on output unless a technology is participating in an ancillary service. This could be a route to encourage larger wind assets to participate on a basis closer to merchant whilst giving the same support to emerging technologies that wind and solar have enjoyed previously.

It is right that the Government is concerned about overcompensating renewable assets to protect households. However, since Russia's illegal invasion of Ukraine the priority needs to be rapidly

[17] Supergen (2023) *What are the UK power system benefits from deployments of wave and tidal stream generation?* Available online.

scaling-up renewable deployment to support energy security and protect UK households from future gas price shocks.

If the UK moves towards a deemed model it is important that the cost of working out the payment is not borne by emerging technologies, which could occur under the second option being considered. In addition, the second option would seem to be the most at risk of gaming and should therefore be discounted.

A deemed model will add more complexity to the energy system, but this may be necessary depending on decisions around zonal or national pricing. We strongly urge the Government to consult further on the deemed model before any such change is implemented. For example, the marine energy industry would require certainty on questions such as whether the equation that decides the output is fixed for the lifetime of a CfD contract, whether there are opportunities for this to change if there were technological improvements, for example through improved blade design.[18]

If the energy system switches to both a deemed model and zonal pricing we would require clarity on:

- Whether the deemed model is the system average price within the zone or based on national prices.
- What scenarios would renewable technologies not receive payments
- How emerging technologies will be protected from network constraints prohibited payment.
- How the deemed model will account for different types of technologies within tidal stream and wave energy.

8. Under a capacity-based CfD, what factors do you think will influence auction bidding behaviour? In particular, please consider the extent to which developers will be able to reflect anticipated revenues from other markets in their capacity-based CfD bid.

Depending on how the Government implements a capacity-based CfD there is a risk that Pot 2 technologies may have to compete on a merchant basis against other more established technologies. It may therefore have little impact on the amount that tidal stream and in the future wave energy would have to bid in at, with the expectation that they will not be competitive in the merchant market.

The UK demonstrated international leadership by setting the tidal stream ringfence. This has put the UK on the pathway to have over 100MW deployed in its seas by 2028. This is an exciting time in which the sector is ramping up investment, deployment, and is committed to playing a key role in the energy future. However, there is significant uncertainty about the benefit of participating in other markets.

This means the capacity award would have to be high enough on its own without the bidder expecting a great deal from other markets.

In other countries where there are feed-in-tariffs this can be accessed in an easier manner and without the auction process. If the Government is committed to introducing a capacity-based CfD removing the auction process for emerging technologies could be a way of providing certainty.

[18] Offshore Renewable Energy Catapult (2024) *Tidal Stream Technology Roadmap.* Available online.

Moving to a capacity-based CfD will introduce uncertainty at a point when the Government should be seeking to address existing uncertainties.

9. **Does either the deemed CfD or capacity-based CfD match the risk distribution you detailed in your response to Q25 on which actors are best placed to manage the different risks?**

No response.

10. **Do you have a preference for either the deemed CfD or the capacity-based CfD model? Please consider any particular merits or risks of both models.**

Our strong preference is for a deemed CfD rather than a capacity-based CfD model. Our reason for this has been set out in the answers to questions 7 and 8.

11. **Do you see any particular merits or risks with a partial payment CfD?**

We believe a partial payment CfD could be of interest, provided the Government reviews the levels in terms of the percentage of an asset's total capacity that will be covered by a CfD for new projects. For emerging technologies like tidal stream and wave energy 90% CfD coverage would be preferable to a 50-50 split which would introduce an unacceptable level of uncertainty and damage the ability of the technology to come down the cost-reduction curve.

One potential benefit is that this approach enables more projects to get deployed and expediates the amount of capacity on the UK's energy system. Tidal stream will be cheaper than new nuclear at 1GW of deployment. Tidal stream will reach £78/MWh by 2035 and below £50/MWh by 2050.[19] A partial payment CfD combined with a commitment for an ongoing ringfence would be consistent with the aim of REMA to rapidly scale up renewable deployment and support investor confidence.

In this scenario renewable projects, that are taking on greater risk, should not be subject to clawbacks based on high wholesale prices.

It is not clear that a partial CfD would address issues such as volume risk and herding.

Finally, if pursuing a partial CfD the Government should also consider extending the duration of contracts that can be awarded from 15 to 30 years.

12. **Do you see any particular merits or risks with the reforms to the CfD reference price we have outlined? Please consider how far the two reforms we have outlined might affect both liquidity in forward markets and basis risk for developers.**
13. **What role do you think CPPA and PPA markets, and REMA reforms more broadly, will play in helping drive small-scale renewable deployment in the near-, mid- and far-term?**

No response provided.

[19] Frost (2022) *Quantifying the benefits of tidal stream energy to the wider UK energy system.* Available online.

Challenge 3: Transitioning away from an unabated gas-based system to a flexible, resilient, decarbonised electricity system.

The Government should not extend the incentivisation of unabated gas for flexibility and security of supply purposes

Below are renewable solutions and services that are consistent with the aims of REMA that can displace the role that unabated gas currently plays on the energy system. Extending the incentivisation will only delay the realisation of these solutions.

Marine energy provides a distinct service to the energy system

Marine energy provides a distinct range of services to the energy system:

- **Predictable -** Tidal stream is an entirely predictable renewable resource, which as already delivered over 60GWh of entirely clean, electricity, to the UK system. Its predictability, and potential for continuous power from the different flow times around the UK, means it is well suited for replacing the firm power role that fossil fuels currently play on the energy system. Modelling by Imperial College London has shown that TSE can reduce the UK's required CCGT capacity to meet its energy needs by over 40%, from 8.1GW to 4.9GW.[20]
- **Reduces need for reserve supply -** Tidal steam adoption enhances supply-demand balancing whilst also reducing the necessity for reserve energy. Research that used the Isle of Wight as a case-study, demonstrated that the reliance on reserve supply would be reduced by 26% with only 120MW of tidal stream deployment.
- **Complementary generation profile with wind –** wave energy has a complementary generation profile to wind, harnessing energy following windy conditions, with a greater resource during winter months when household electricity demand increases.
- **Significant potential -** The UK has over 30GW of unharnessed marine energy resource and the British Energy Security Strategy (BESS) committed to aggressively exploring renewable opportunities afforded by UK geography. The marine energy sector requires more clarity as to what this will look like in practice. When harnessed marine energy could provide around a third of the UK's current electricity demand.

As the UK becomes increasingly dependent on wind and solar energy marine energy will provide a critical enabling role for the transition to an energy system that delivers net zero.

The UK can harness its indigenous resource with indigenous supply chains

Marine energy is being delivering with significant UK supply chain content spend. Orbital Marine Power's O2 device was delivered with 80% UK supply chain spend. The O2 was conceived in Orkney, designed in Orkney and Edinburgh, built in Dundee with steel from Motherwell, blades from the Solent, anchors from Anglesey and hydraulics from the Midlands. In the first 18 months of operation of Nova Innovation's world-first offshore tidal array in Shetland, 98% of supply chain expenditure went to UK companies, with 60% going to companies in the Highlands and Islands region.

[20] Frost (2022) Quantifying the benefits of tidal stream energy to the wider UK energy system, available online.

The UK's ability to act independently in developing supply chains and harnessing its marine resource is significant. By supporting marine energy now, the UK Government not only bolsters energy security but could embed UK supply chain content in projects around the world. Ocean energy has a global potential of 350GW by 2050.[21] The UK should seek to capture as much of this market as possible, and this should be a goal of the REMA process.

Marine energy is well placed to support battery storage and provide renewable baseload.

TSE when partnered with battery energy storage system (BESS) technology, provides renewable baseload energy. Scottish tidal energy developer Nova Innovation has already piloted this approach with a pioneering BESS and tidal project, which has been operating since 2018 at their Shetland Tidal Array, providing flexible, reliable power to the grid.

Diversity and innovative deployment of renewable technologies will be key in optimising how the energy system is utilised. Waves are created by winds but provide a more consistent generation profile and can be harnessed 3-8 hours after the energy is initially harnessed by wind farms. Co-locating offshore wind and wave energy converters allows technologies to share assets and can reduce costs by 12% for both projects.[22]

14. **Are there any unintended consequences that we should consider regarding the optimal use of minima in the Capacity Market (CM) and/or the desirable characteristics it should be set to procure?**
15. **What aspects of the wider Capacity Market (CM) framework, auction design and parameters should we consider reviewing to ensure there are no barriers to success for introducing minima into the CM?**
16. **Do you agree with the proposal that new lower emission limits for new build and refurbishing CMUs on long-term contracts should be implemented from the 2026 auctions at the earliest?**
17. **If you are considering investment in flexible capacity, to what extent would emissions limits for new build and refurbishing capacity impact your investment decisions?**
18. **Considering the policies listed above, which are already in place or in development, what do you foresee as the main remaining challenges in converting existing unabated gas plants to low carbon alternatives?**
19. **Do you think there is currently a viable investment landscape for unabated gas generation to later convert to low carbon alternatives? If not, please set out what further measures would be needed.**
20. **Do you agree that an Optimised CM and the work set out in Appendix 3 will sufficiently incentivise the deployment and utilisation of distributed low carbon flexibility? If not, please set out what further measures would be needed.**
21. **Do you agree that our combined proposed package of reforms (bespoke mechanisms for certain low carbon flexible technologies, sharper operational signals, and an Optimised Capacity Market) is sufficient to incentivise flexibility in the long-term? Please set out any other necessary measures.**

[21] IRENA (2023) *Scaling up investments in ocean energy technologies*. Available online.
[22] OWC (2023) *Wave and Floating Wind Energy, opportunities for sharing infrastructure services and supply chain.* Available online.

Challenge 4: Operating and optimising a renewables-based system, cost-effectively [23]

22. Do you agree with the key design choices we have identified in the consultation and in Appendix 4 for zonal pricing? Please detail any missing design considerations.

We agree that the main design choices identified in Appendix 4 are the key considerations for a future zonal pricing model. The decisions that DESNZ on each of options will have a varying degree of impact on the marine energy and renewable industries. It is imperative therefore that the Government presents fleshed out zonal models to consult with industry on, prior to the implementation of such a radical shift.

Each proposed zonal model should also have a thorough system analysis to understand its relationship with the other changes implemented via the REMA process. The Government should set out clearly the zonal models that it wants to take forward, with decisions taken on the considerations it lays out, for the energy industry to review and respond with missing details.

If a zonal model is implemented the MEC supports two to six zones being taken forward

A move to a zonal model would be a radical and disruptive change. Before its introduction we would expect more consultation on the specific design choices, and their implications to be undertaken by DESNZ.

In general wave and tidal stream energy being able to capture consistently higher prices than wind or solar in every zone. This is due to the offsetting of marine renewable resource with wind and solar, meaning that wave and tidal energy can capture higher prices at times of low wind and solar availability.[24] If a zonal model is pursued our preference would be for fewer zones to give marine energy opportunities for higher price capture.

An important caveat to this is that the price capture of wave and tidal would be lower in northern zones, where the greatest amount of marine resource is found. If a shift is undertaken the UK Government should ensure that emerging technologies are protected and supported in all locations to come down the cost reduction curve. In this regard deployment of tidal stream or wave energy anywhere benefits sites everywhere. This is because as the Offshore Renewable Energy Catapult has demonstrated getting to 1GW of deployment will mean marine energy is cheaper than new nuclear, and on the path to below £50/MWh.[25]

Zonal boundaries changes should be reviewed at a lower frequency than every three years

We would support reviews of zonal boundaries taking place less frequently than every 3 years. For the benefits and investment signals to be clear to the renewable industry frequent boundary changes risks adding increased uncertainty during a period where maintaining investor confidence will be critical.

Due to the length of time it takes to deploy a marine energy project (due to regulatory, environmental, leasing and network processes rather than due to the technology) consistent

[23] Please see Annex 1 for a zonal analysis summary on the impact on marine energy through moving to a zonal model.
[24] Please see tables 1 and 2.
[25] Frost (2022) Quantifying the benefits of tidal stream energy to the wider UK energy system, available online.

investment signals will be required to attract funding into marine renewables where it can play a key role and take advantage of its complementary generation profile with solar and wind.

System benefits must be valued in the transition to a zonal price model

Zonal pricing with a capacity-based CfD may lead to a situation where emerging technologies receive a lower payment than deemed pricing or the current CfD with reform option. We have long argued that the system benefit of a mix of renewables is currently not valued. Zonal pricing could provide the market signals to address this, provided the renewable deployment mechanism is aligned with securing a diverse energy mix. Research shows that deployment of just over 12GW of wave and tidal stream energy will **save the UK £1bn in energy system cost**. This is due to avoiding expensive peaking generation and storage necessary in a net zero energy system dependent on intermittent renewables.[26]

23. How far would our retained alternatives to locational pricing options go towards resolving the challenges we have identified, compared with locational pricing? Please provide supporting evidence and consider how these alternative options could work together, and/or alongside other options for improving temporal signals and balancing and ancillary services.

Strong locational TNUoS would be detrimental for marine energy development.

Marine energy could potentially benefit from zonal pricing and its complementary generation profile with wind and solar. However, with changes to TNUoS there is a risk that it faces punitive costs without benefit or the Government recognising or accurately valuing its role in the energy mix.

Emerging technologies should be provided with firm access rights to the transmission network

The growth of marine energy in the UK poses a much lesser burden on the existing electricity network than multiple GW offshore wind farms. Emerging technologies like tidal stream and wave energy should be provided with firm access rights, or compensated should the network be unable to deliver energy to demand. Removal of this will pose a significant risk to investor confidence in marine energy.

Strategic planning of the electricity network could help reduce costs in the long term.

We know where the tidal stream resource exists in the UK's waters, and the amount of network capacity that will be needed to ensure this can be harnessed and transported to communities, businesses, and homes. The critical expansion of the UK's network infrastructure should be undertaken in a way that avoids a piecemeal approach to expansion, but ensures that the network capacity is in place at these locations.[27] Such an approach could also explore the added value seeking to provide continuous power from the different flow times around the UK.

Planning, leasing, and consenting are critical factors in marine energy which is highly location dependent. The Government should consider how these can be better aligned and support mechanisms provide the right incentives and clarity for industry to go through the costly process of making capacity eligible for renewable support schemes in the future.

[26] Supergen (2023) *What are the UK power system benefits from deployments of wave and tidal stream generation?* Available online.
[27] Coles et al (2023) *Impacts of tidal stream power on energy system security: An Isle of Wight case study.* Available online.

Grid capacity increase should be a priority focus

Grid constraints should be addressed regardless of the model pursed following the REMA process. There is a significant risk that the UK becomes an unattractive location to invest in innovative renewables for a net zero future as they could get crowded out by more established technologies, in which the UK is dependent on imports and already have sticky supply chains established globally.

24. **Do you agree with our proposed steps for ensuring continued system operability as the electricity system decarbonises? Please detail any alternative measures we should consider and any evidence on likely impacts.**

No response provided.

25. **Which market actors (e.g. generators, suppliers, consumers, government) are best placed to bear / manage different types of risk?**

Delivery of the UK's net zero ambitions requires governments, industry, regulators and wider stakeholders working closely together. It is right that risk and reward is considered and balanced between different actors in the energy system. Currently there is too much policy uncertainty for emerging technologies and marine energy sites which is stifling progress to realising the UK's full potential. It is imperative that as changes are implemented via the REMA process that barriers to development are addressed and further risk is avoided.

Risk- resource availability

Marine energy, and in particular tidal stream, has a different risk profile to other renewables. Tidal stream is entirely predictable renewable energy resource, and we know what can be harnessed, where and when. This should be valued accurately and prioritised in the allocation of renewable funding.

Depending on the decisions taken around the CfD mechanism there is a risk that this is not accurately valued and supported, and there is support for low-capex projects which do not play as valuable of a role in the future energy mix. Tidal stream is a firm power resource and should be categorised as such.

Risk – clear route to market (or lack of)

There is currently significant risk borne by emerging technologies that is stifling the sector's development. This is caused in part by CfD budgets and ringfences being announced on an annual basis. The process of making capacity 'eligible' to bid into the CfD is a costly process. As budgets and ringfences are announced on an annual basis emerging technologies have no clarity that support will be in place after going through the process of making capacity eligible for CfD auctions.

Risk – technical project considerations

It is right that technical project issues are held by the asset owners. The CfD mechanism which provides payment based on output has been effective in placing this on renewable projects, whilst avoiding excess payments at the cost of consumers.

Risk – competition from other generators and technologies

The Government is right to maintain different Pot structures for more and less established technologies, and ringfences within Pot 2. There is a risk that as the REMA process adds increased

exposure to renewables to market risks and signals that emerging technologies are unable to compete.

In principle the risk of competition should be held by asset owners. In marine energy technologies compete against each other to secure contracts. However, the government has already introduced different models for long duration storage, nuclear and other energy technologies. This recognises that different technologies provide different services to the energy system. Any changes in the REMA process must recognise and incentivise increase marine energy deployment as tidal stream and wave energy will play distinct and important roles in the future energy mix. Marine energy growth should not be curtailed by premature exposure to competition with more established renewable technologies.

26. Do you agree with our initial assessment of the compatibility between our remaining options? Please set out any key interactions we have missed.

No response provided.

27. Do you agree with our approach to assessing the impact of REMA reforms on Legacy Arrangements?

We believe that DESNZ should commit to grandfathering all contractual arrangements agreed under government support schemes at a minimum until the conclusion of the REMA process and final decisions, but preferably until the outcomes of REMA have been implemented.

Annex 1

Zonal Model Analysis summary by Shona Pennock, Energy Systems Engineer at CorPower Ocean

Executive Summary

Dispatch models created within the EVOLVE project represent the GB electricity system with nine zones, ranging from the very north of Scotland (z1) to the south of England (z9). An exploration of the resultant zonal marginal prices in high renewable scenarios (e.g. National Grid's Leading the Way scenario - LTW) has resulted in the following findings:

- The number of hours where zonal splitting occurs increases with higher renewable capacity in future energy scenarios – from 871 hours (10% of year) in LTW 2030, to 1721 hours (20% of year) in LTW 2050.
- Considerably higher zonal marginal prices were observed in more southerly zones within GB – for example for LTW 2030 the average marginal prices in the south of England were approximately double those in the north of Scotland.
- Price capture for renewable energy sources follows a similar pattern, with considerably higher price capture for all renewables (wind, solar and marine) in the southerly zones in GB.
- Marine energy (both wave and tidal stream) is able to capture consistently higher zonal electricity prices than wind or solar, due to temporal offsetting of resource.

These findings highlight the potential risks and implications of introducing zonal pricing to Great Britain:

- Price risk for generators locating in the north of GB, gaining less revenue under zonal pricing. With a large proportion of the available renewable resource in Great Britain located in these northerly zones (particularly wind, wave and tidal) this could also put GB Net Zero targets at risk if projects are not developed the north of GB.
- Risk of interactions with CfD mechanism:
    - If zonal prices are used as reference prices, but strike prices remain the same, the total spend under the CfD mechanism could increase considerably.
    - If the average GB system reference price calculation and strike prices both remain the same, then renewable generators in the north of GB may not be able to recover their long-term costs through the CfD mechanism.

Methods - EVOLVE Dispatch modelling

The EVOLVE project[28] was a transnational partnership between research institutions, technology developers and established industry organisations, funded by the OCEANERA-NET cofund. The project has quantified the benefits associated with integrating ocean energy in low carbon energy systems across Europe.

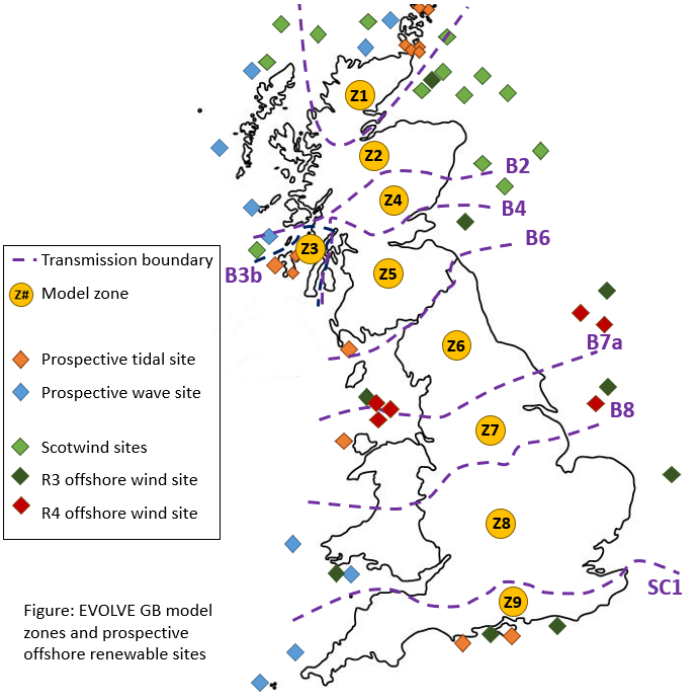


Figure: EVOLVE GB model zones and prospective offshore renewable sites

Dispatch models were developed for three regions of interest: Great Britain, Portugal, and Ireland[29]. Python for Power Systems Analysis (PyPSA) software was used to compute hourly optimal dispatch. The GB model was split into nine zones (as illustrated) based on selected National Grid boundaries. A detailed description of the model creation, including modelling constraints, data inputs and outputs can be found in Pennock et al 2023[30].

The 'Leading the Way' (LTW) 2021 Future energy scenario published by National Grid ESO has been used as the basis of future supply and demand projections. This is a high renewable scenario, reaching net zero before 2050, with wind and solar making up the highest proportion of new installed renewable capacity in the coming decades.

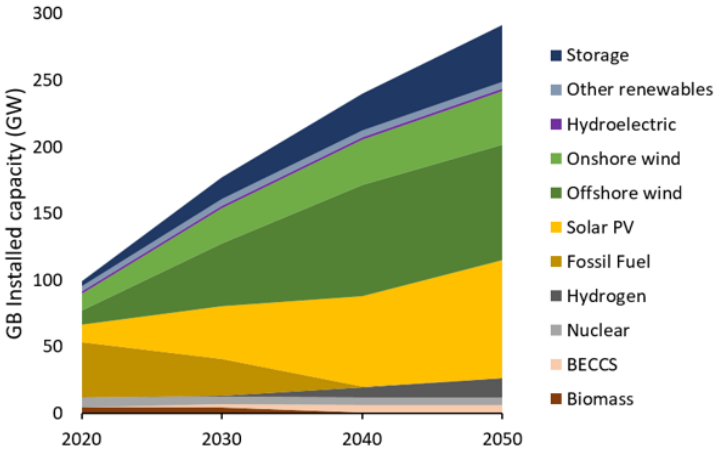


Figure: Installed capacities for National Grid ESO Leading the Way scenario 2020-2050

[28] https://evolveenergy.eu/
[29] https://evolveenergy.eu/wp-content/uploads/2023/01/EVOLVE-technical-note-The-system-benefits-of-ocean-energy-to-European-power-systems.pdf
[30] https://doi.org/10.1016/j.apenergy.2023.121413

Results and Discussion

Table 3 shows the resultant average zonal prices (top row) and renewable price capture for each zone for the LTW 2030 scenario, in £/MWh. For this year of hourly results, zonal splitting occurred in 871 hours (approximately 10% of the year). It can be seen that the higher average zonal prices occur in the southerly zones, particularly zone 6 to zone 9 (England and Wales). There is also considerably higher price capture from renewables in these southerly zones, particularly zones 8 and 9 in the south. This result is expected, as with a higher installed capacity of price-setting fossil fuels in the southerly zones, when market splitting occurs the high-renewable northerly zones will experience higher instances of zero or negative pricing. It can also be seen that wave and tidal are able to capture consistently higher prices than wind or solar, in every zone. This is due to the offsetting of marine renewable resource with wind and solar, meaning that wave and tidal energy can capture higher prices at times of low wind and solar availability. However, we do still see that the price capture of wave and tidal is lower in the northern zones, where the greatest amount of marine resource is found (z1 and z2 in particular).

Table 3. Resultant average zonal marginal prices (red) and renewable energy price capture (green) for LTW 2030 scenario, all in £/MWh

	z1	z2	z3	z4	z5	z6	z7	z8	z9
Av zonal price	23,86	26,91	28,31	40,07	26,44	41,47	38,39	44,91	42,23
Wave	35,61	37,57	n/a	n/a	n/a	n/a	n/a	39,18	46,81
Tidal Stream	35,31	n/a	38,34	n/a	36,41	n/a	36,70	n/a	43,77
Onshore wind	22,21	23,47	17,09	21,67	20,45	26,27	23,38	30,45	39,12
Offshore wind	23,05	22,79	22,58	23,93	22,82	26,59	25,08	29,21	38,24
Solar PV	21,24	23,93	23,46	22,85	22,60	24,35	21,34	22,68	31,23

Table 4 shows the resultant average zonal prices and renewable price capture for each zone for the LTW 2050 scenario. For this year of hourly results, zonal splitting occurred in 1721 hours (approximately 20% of the year), with almost double the instances of zonal splitting compared to the LTW 2030 scenario previously. Again, it can be observed that the higher average zonal prices occur in the southerly zones, and that the price capture from renewable energy is also higher in the southerly zones. It can also be seen that wave and tidal are able to capture higher prices than wind or solar in every zone, but that the wave and tidal price capture is higher in the south of England than comparably in the north of Scotland. These results overall are consistent with the 2030 scenario, demonstrating that the potential issues with renewable generation receiving lower revenues in northerly zones occurs across the full timeframes of these future scenarios.

Table 4. Resultant average zonal marginal prices (red) and renewable energy price capture (green) for LTW 2050 scenario, all in £/MWh

	z1	z2	z3	z4	z5	z6	z7	z8	z9
Av zonal price	14,52	17,23	13,40	24,31	17,12	25,51	30,46	32,73	32,16
Wave	34,64	29,98	n/a	n/a	n/a	n/a	n/a	27,02	37,74
Tidal Stream	29,98	n/a	32,86	n/a	30,68	n/a	30,51	n/a	37,74
Onshore wind	0,86	1,43	12,82	10,95	13,73	19,82	17,54	19,27	29,47
Offshore wind	13,88	13,67	7,95	12,60	14,59	18,56	15,77	18,87	27,86
Solar PV	12,97	14,35	12,15	12,42	13,60	15,25	12,65	13,04	21,14