Introduction

EMEC was founded in 2003 in Orkney and is the only accredited wave and tidal test centre for marine renewable energy in the world. EMEC has hosted 22 wave and tidal energy clients (with 35 marine energy devices) spanning 11 countries. EMEC's operations have developed significantly through the years as we have gained unprecedented experience in demonstrating ocean energy technologies.

Today EMEC is also pioneering the development of a green hydrogen ecosystem in Orkney, having set up a hydrogen production plant onshore in 2016, next to its tidal energy substation. EMEC collaborates on hydrogen research projects and offers a demonstration site for new hydrogen technologies. Most recently EMEC's project involvement has focused on hydrogen demonstration in the marine and aviation sectors. EMEC's work has also expanded into other technology areas, such as hosting a subsea data centre designed by Microsoft.

Furthermore, EMEC aspires to apply its offshore laboratory expertise and expand Scotland's test and demonstration facilities to accommodate floating offshore wind technology, in response to significant demand from the sector. EMEC is proposing a floating offshore wind test and demonstration site to the west of the Billia Croo wave test site in Orkney.

Chapter 1: Introduction and Vision

1. What are your views on the vision set out for 2030 and 2045? Are there any changes you think should be made?

Marine energy

EMEC supports the UK Marine Energy Council (MEC) in welcoming the Scottish Government's ambition to prepare Scotland for a just energy transition, and an energy system that provides maximum community and economic benefit. EMEC agrees with the position of Scottish Renewables that the term "maximum benefit" might be slightly nebulous and would benefit from being clearer in terms of what outcomes the Government wants to deliver. EMEC supports Scottish Renewables suggestion that this should be amended to "*We will maximise benefit for Scotland…*", and that this could compel projects or initiatives to provide evidence that they had provided significant benefit to Scotland.

EMEC strongly supports the Scottish Government expanding its Supply Chain Development Programme and seeking to create green jobs across Scotland.

The vision could include greater consideration about how the Scottish Government can support delivery of a cost-effective net-zero energy system, and how this can be achieved through a diverse mix of renewables. Research by the University of Edinburgh has found that deployment of just under 13GW across the UK of marine energy will reduce annual dispatch cost from £13.54bn to £12.51bn. This is a saving of £1.03bn annually for UK and Scottish households[1].

The Scottish Government is right to note that net zero presents a significant opportunity to deliver benefits to Scotland's economy and communities. In response to questions 11 and 12

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

EMEC notes the role of marine energy in realising this vision. It would be welcome if the Scottish Government explicitly noted the role of marine energy in delivering this future (figure 8 and figure 9, P.8-9 in the Draft Energy Strategy and Just Transition paper).

Energy matters more widely

EMEC would support greater clarity on the benefits that the Government is trying to deliver as part of realising this vision, noting Scottish Renewables' view that the aims set out under *climate and environment* and *economy, business and workers* can all be quantified and progress measured using clearly identifiable data such as the volume of renewable generation capacity, GVA to the economy, job numbers, biodiversity surveys and so on. The aims set out under *communities and regions* are far more ambiguous and it is unclear how these would be evidenced and evaluated.

For example, issues which may need addressed include: reducing energy consumption, changing lifestyles, and consuming less energy from one perspective so more can be consumed elsewhere. The strategy would also benefit from more detail on circularity, which can increase energy security through reusability of critical materials, and more generally essential for environmental sustainability. This also provides scope for jobs, but needs to be understood in relation to consenting, licensing and planning processes for future renewable energy projects; and is important in terms of international supply chain impacts.

Neither the 2030 or 2045 Visions mention eFuels from green hydrogen and air captured carbon. EMEC believes this is an omission.

Finally, EMEC believes that reaching these Visions will be contingent upon the successful driving of technology along its learning curves. This means the more of it that is undertaken, the cheaper it becomes. To facilitate that repetition, it is critical to have consistent, reliable funding support to help move new innovation beyond early Technology Readiness Levels.

Chapter 2: Preparing for a Just Energy Transition

2. What more can be done to deliver benefits from the transition to net zero for households and businesses across Scotland?

EMEC currently hosts a PhD researcher whose research is focused on an energy justice and responsible innovation enquiry into 3 emerging technologies: wave, tidal and green hydrogen in island communities. This research explores these emerging technologies which are not yet 'locked into' our current systems, to anticipate their potential risks of injustice, and the opportunities they offer for building just energy transitions. In doing so, it also contextualises them into the Orkney Islands where they are being demonstrated, to understand their potential role in a just (or unjust) energy transition for Orkney. EMEC would offer access to this research to aid further development of this Strategy.

Whilst it is positive to see development of good practice principles for community benefit from offshore renewable energy developments, this should be a guideline document and should not substitute place-based assessments and engagement. It is particularly important that community 'benefit' does not equate to community 'payoff'. Communities can benefit from particular technologies more than others, even if these are more costly; and harm can be created by offshore deployments that cannot be quantified in a £/MW payment. Establishing a standard creates a direct risk of ignoring communities' real needs, concerns and opportunities from offshore deployments which could be dramatically different in each place.

It is also important to rethink key criteria for greater benefit/engagement when it comes to deployment. This is made even clearer with offshore developments where at times, 'community' could be offshore open sea transit passengers, marine biologists, or a local place where a cable lands or substation is built. At the moment, project scale and proximity to a place automatically sets the boundaries for engagement. Scotland has an opportunity to think more widely in how to define these lines. This also appeals to the global nature of energy impacts, climate impacts and offshore infrastructure supply chains, where the 'community' impacted by these decisions of mass infrastructure deployment is much greater. There is a need to consider nearshore marine renewables in any offshore community benefit strategy as there is a different nature and impacts to fully offshore developments (e.g. tidal deployment vs. offshore windfarm vs. fully offshore).

Missing in the Just Transition vision for Scotland is the international lens. It is necessary to make sure that jobs are not 'offshored' to avoid local transition efforts and in doing so introduce injustice elsewhere. This is important so that Scotland delivers on climate emergency and climate justice narratives and commitments, but also more generally, so that the costs of Scotland's success is not borne elsewhere. These are global problems which require whole-systems lens of analysis when it comes to assessing risks and consequences.

3. How can we ensure our approach to supporting community energy is inclusive and that the benefits flow to communities across Scotland?

To an extent, part of the objective of community ownership of renewables is achieved by the structure of ownership of the seabed for marine renewables. Ownership of the estate is vested with Crown Estate Scotland (CES) and the proceeds of the exploitation of the estate flow back to the state. The foreshore across which some cables and pipes will cross is similarly in CES ownership.

The actual means of energy production is, however, going to be led principally by private companies. There will be opportunities for communities to participate in the development of projects and these opportunities should be fostered by government policy and certainly not hindered by it.

An example of such hindering was evident during initial leasing rounds by the predecessor organisation to CES where community attempts to become lease holders were thwarted by unaccountable actions by The Crown Estate. This disenfranchisement of the local communities was not deliberate, but it was unwelcome and unfair. It also led to unsatisfactory outcomes with most of the agreements to lease being quietly handed back by the 'blue chip' multinational companies as they walked away. Had the leases been more locally owned then more progress would have been made and residual value would have been left in the communities.

EMEC would therefore urge that attention be paid to the risks of biases against community-based initiatives in the huge task the nation faces of decarbonisation.

Comment: P58., "we are encouraging developers to offer community benefits" is vague and could be strengthened to an obligation. An examination of public sector duties and limitations when it comes to generating/procuring electricity needs should be undertaken to ensure this is not a barrier to community-led decarbonisation.

4. What barriers, if any, do you/your organisation experience in accessing finance to deliver net zero compatible investments?

The biggest single barrier to finance to zero carbon investments is the absence of a realistic price for the alternative i.e. it is still usually cheaper to fly-tip carbon in the atmosphere than it is to do the 'right thing'. This has to change.

EMEC is clear that during its 20 years of existence the issues of Net Zero have never been more widely known and understood. The appetite of investors to find returns through sustainable investments is also strong as they too can read the writing on the wall for unsustainable fossil fuelled activities. However, the need to make a return presently often outweighs the longer-term sustainability of investment.

In addition, the risk appetite of the bulk of the investment market is not yet over the tipping point where fossil-based investments are as socially and politically unacceptable as has been the case in other changes. However, it feels that they are close to this point and some further nudges from government in terms of policy instruments will cause the movement needed to tip the balance. Once tipped the finance will naturally flow into sustainable activities.

At present Government signals are ambiguous. There are strong signals about the need to get to Net Zero, however there are also unhelpful signals about the need to retain oil and gas activities and revenues. It is clear that the financial weight of past investments in fossil fuel production is significant in the Scottish economy and has been very beneficial. However, it is EMEC's opinion that there is a very serious risk that the opportunity to see similar benefits from the Net Zero economy will be missed unless investment is directed solely towards Net Zero now. EMEC therefore urges that the narrative of 'the importance of fossil fuels in the transition' is stopped and that every opportunity is taken to drive to Net Zero without the drogue of appeasing incumbent investments.

In EMEC's experience, the marine energy industry has particularly suffered from inconsistent support and has not had comparable investment or R&D support as received by other renewable technologies. It is critical now for Scotland, to retain the benefits of the pioneering technology development, that a support programme be put in place with clear, consistent funding support to ensure the innovation can be commercialised and deployed at scale.

5. What barriers, if any, can you foresee that would prevent you/your business/organisation from making the changes set out in this Strategy?

Marine energy barriers

For Scotland to realise the benefits of the marine energy industry it is imperative that more technology goes into Scottish waters.

The results of the CfD Allocation Round 4 will mean more tidal stream capacity will be deployed in Scotland than has been deployed internationally in the last 15 years. This leadership will be put at risk if more is not done to address issues around accelerating consent and making more capacity eligible for future CfD rounds.

Consenting and reaching a final investment decision are both key milestones on the road from in development to fully operational, and barriers to either of these can derail project delivery. It is essential that the Scottish Government is keenly focused on ensuring Scotland's consenting regimes and policy environment make this a smooth journey.

Lack of clarity and guidance on Environmental Impact Assessments and Habitat Regulations Assessments are major barriers to the timely and efficient consenting of projects, as is the lack of capacity in the consenting processes. Attention also needs to be given to the need for greater certainty in the policy environment, particularly around the need for clear timelines for leasing rounds.

If Scotland is to maintain its position as a global leader in marine energy, it is critical that it is not marginalised within Marine Scotland's ORE planning consenting workstream priorities, including the ScotWind programme. The Scottish Government should update consenting guidance and ensure there is resource allocated within Marine Scotland to expediate the consenting process.

It should be noted that current offshore consenting regime has been designed primarily with large scale offshore wind in mind. The Scottish Government should consider reducing the need for two year's pre-application survey for birds and mammals and shift some effort to post-consent monitoring (particularly where this is part of a formal adaptive management framework to support project phasing).

It is essential that a focus on the benefits the transition to net zero will bring does not result in a lack of focus on the actions needed to bring forward the projects that will deliver these benefits.

Floating Offshore Wind barriers

Scotland needs a floating offshore wind test centre modelled upon EMEC.

For the UK to fulfil its ambition to successfully deploy more than 1,000 floating offshore wind turbines in UK waters, and then to continue to harvest energy from them over their full working life of 25-50 years, it will be critical to ensure that each configuration deployed has been designed for the conditions it will face and has been sufficiently tested and proven for both performance and survivability. Doing so prior to project design freeze significantly de-risks projects at an early stage and reduces the likelihood of expensive failures once serial manufacture begins and floating wind turbines are deployed offshore in large numbers. Consequently, it is essential to technically prove that a particular design or turbine-platform combination will be suitable for the site to which it will be deployed, thereby ensuring that a project can proceed past the insurance and technical due diligence phase of project financing. Failure to do so risks insurers, lenders or investors delaying committing funds to a project until such evidence is provided and can render the project more difficult and expensive to finance or insure, or both.

Test and demonstration facilities such as EMEC is proposing enable prototype and demonstrator series technologies – as well as as-yet unproven sub-systems like quick-release electrical and mechanical connection systems - to be put through their paces in challenging real-world conditions that are as fully representative of their eventual deployment locations as possible. Test and demonstration facilities are therefore a key infrastructure requirement to reduce project risk and enable the earliest and safest progression to serial manufacture and mass deployment of floating offshore wind platforms and technologies.

There are currently few such test and demonstration sites for floating offshore wind in the UK, and none that have both the experience, track-record and local supply-chain backup as EMEC, and sufficiently challenging metocean conditions to properly test floating offshore wind technologies to the standard required for UK and international deployments. We believe this is a shortfall that needs to be addressed in order to de-risk technologies prior to manufacture

and deployment, and an opportunity to develop and capture unique test and deployment skills and expertise within the UK supply chain prior to mass commercial roll-out.

Furthermore, as the number of floating offshore wind projects and concepts in European waters grow, having such test and demonstration capability within UK waters and under UK control means less dependency on overseas providers, and no risk of developers of UK technologies and projects being delayed 'waiting for a slot' at a facility where priority might be given to other users by other actors. Floating wind offers the UK an important opportunity to capitalise on its world-leading research base by focusing attention on the "Demonstration" aspect of R&D, an arena which we have generally been poor at.

Clearly, levering private investment into floating offshore wind at the scales required for net-zero requires investor confidence in how floating offshore wind technologies perform. With nearly 20 years' experience operating as a test and demonstration centre, EMEC can offer numerous examples of the value of demonstration projects to commercialising offshore technologies.

Fundamentally, it is only when something is subject to real at-sea trials that developers can properly understand how well their technology works offshore. Dedicated test and demonstration facilities like EMEC allow advanced testing of installability, operability, availability, maintainability, scalability and survivability, all of which reduce risk and facilitate speed-to-market and cost reduction. The more a technology is tested and proven, and the more its efficiency is demonstrated and refined, the less likely it is to fail in operation, and the easier it is to finance and deploy.

As the only accredited test centre for wave and tidal renewable energy in the world, EMEC has an established and fundamental role in verifying performance before investment can happen. EMEC believes that it could run such a site and help deliver floating offshore wind earlier than will otherwise be the case.

Green hydrogen barriers

Whilst the world has woken up to the opportunities that hydrogen can deliver there is a great deal of uninformed hype around it. It is universally accepted that the only sustainable source of hydrogen is 'green' and, if pursued at all, blue hydrogen has a limited life driven by dwindling fossil gas reserves.

The production of hydrogen is therefore largely limited by the fact that Scotland has not been doing it. i.e. there are no present facilities at scale in Scotland and consequently there is little operating experience.

However, it is probable that the greater limitation is due to it not being clear how hydrogen will be used. Will it be used in land, sea, air transport, in heating homes, businesses and industry or as a feedstock? Significant further exploration of the options and challenges needs to be urgently and aggressively undertaken to determine which options should be pursued.

EMEC has led the way in the production of hydrogen in Orkney and EMEC's experience is that there are significant advantages in looking to use hydrogen in the production of synthetic fuels that are free of fossil carbon and would strongly suggest that this area requires increased attention and support.

The ease of storage and handling of synthetic fuels made from electrolytic hydrogen and air captured carbon seems to outweigh the challenges of the fuel synthesis process. This area requires thorough examination and exploration in order to decide what will be done with the

hydrogen to be produced from renewables. If, as EMEC believes, most hydrogen will be quickly turned into synthetic fuels then this could significantly reduce the scale of electrical transmission infrastructure required to move 'Scotwind' energy south.

For the record, EMEC does not see much opportunity for hydrogen in lightweight road transport as batteries are already adequate. Furthermore, EMEC does not see the point in using green hydrogen wastefully for heating by sending it to the present poor Scottish housing stock. Far greater effort needs to be put into insulating properties and then reducing the fuel need. This will then better allow for heat to be supplied to properties through district heating systems making the supply of hydrogen to homes and businesses unnecessary.

The point here is that Scotland needs to decide what it wants to do with hydrogen and then commit to the coming change. The decision needs to be based upon more extensive experimentation and that in turn needs an effective and well-funded R&D programme to determine hydrogen's optimal use.

EMEC would be happy to expand further on this point upon request.

6. Where do you see the greatest market and supply chain opportunities from the energy transition, both domestically and on an international scale, and how can the Scottish Government best support these?

There is a clear opportunity to develop an offshore industry that is the basis for both the marine and offshore wind sectors. The UK is a global leader in offshore wind with the most installed capacity in Europe. However, projects are being delivered with unnecessarily low levels of UK content. Tidal and wave projects are currently being delivered with up to 90% UK content, whereas the domestic content of early offshore wind has been around 32%[2] and may well be lower in coming rounds.

Supporting the deployment of wave and tidal energy therefore gives much greater benefit to the Scottish economy per pound spent than offshore wind. EMEC believes this support is essential and will need scaling up. It is noticeable at present that support for marine is largely being delivered through CfD based support and residual European programmes. This arena would benefit from Scottish involvement, particularly given the strength of Scottish companies in this developing area and the local marine resources.

The development of an encompassing indigenous industry, for which Scotland already has a first mover advantage, does indeed make Scotland a future exporter, as rightly pointed out by the Energy Strategy and Just Transition paper. EMEC would however caution against being overly focussed on the export potential at this stage. Exports without a strong home market will inevitably lead to problems of support (from a distance) and the likely long-term loss of the indigenous capacity to the overseas sites. EMEC firmly believes that the establishment of a strong home market underpins exports.

Marine energy

There is significant potential for the Scottish Government to position Scotland to benefit from a growing marine energy export market that is forecast to be worth £76bn[3] by 2050.

[2] Catapult ORE (2017), *The Economic Value of Offshore Wind*. Available online.

[3] Highlands and Islands Enterprise (2016), *Marine Energy. Key steps to maintain a Great British Success Story*. Available online

Wave energy is probably the world's largest untapped source of energy with the Intergovernmental Panel on Climate Change (IPCC) estimating that the potential annual global production at 29,500 TWh, which could provide clean electricity for over 500 million homes. Ocean Energy Europe's 2030 Ocean Energy Vision report states that 1.3 GW to 2.4 GW of installed capacity from tidal energy could be deployed worldwide by 2030 and potentially more than 100 GW by 2050[4]. Organisations such as the International Renewable Energy Agency (IRENA) have identified the enormous global potential of marine energy.

Scotland has significant supply chain potential. 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 and with steel from Motherwell. In the first 18 months of operation of Nova Innovation's world's 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. For comparison, domestic content of early offshore wind was around 32%.

To develop the renewable energy supply chain in Scotland across all technologies, maximise the economic benefits of our sustainability pipeline and ensure a just transition for suppliers, EMEC recommends the Scottish Government adopts Scottish Renewables' asks:

- Establishes a Low-Carbon Industrial Strategy that includes a Supply Chain Plan to drive forward renewables-led investment and a just transition for Scottish clean energy suppliers and manufacturers;
- Supports the immediate growth of Scottish renewable energy suppliers by working with near-term net-zero projects to assist in the success of local supply chain companies;
- Enhances the role that Scottish ports play in building a low-carbon economy through a net-zero ports and infrastructure programme;
- Achieves growth for small and medium low-carbon suppliers by introducing a supply chain SME support mechanism;
- Enhances export opportunities for Scottish suppliers by promoting and supporting companies moving into international markets.[5]

Floating Wind

Confidence-building in terms of meeting national climate objectives will come from ensuring supply chains are based in Scotland. Scotland once led the world in onshore wind innovation and development, but that lead was lost and the knowledge effectively sold to the highest bidder. Fortunately for the climate the UK has been able to easily 're-import' from abroad the wind technology it previously sold off, but this has been at the cost of balance of payments capital outflows, and other countries – notably Denmark and Germany.

Moreover - and particularly important given UK and Scotland goals of employment and just transition - the lower cost of electricity production from these turbines that were manufactured overseas and just 'dropped off' in UK waters did not, in fact, result in higher value for the UK. While a big part of the UK electricity system was successfully decarbonised, the low levels of UK content in these offshore wind projects demonstrates the historic failure to capitalise on

[4] Ocean Energy Europe (2020), *2030 Ocean Energy Vision: Industry analysis of future deployments, costs and supply chains,* pp.8-9, Available online

the potential jobs and supply chain opportunities that should have been due. This mistake should not be repeated with marine energy.

As outlined in the response to question 5, it would be an embarrassing and costly failure to correct if major floating offshore wind components and sub-systems failed during or after deployment. Not many in the sector remember the first Horns Rev offshore wind project, but correcting gearbox manufacturing and design flaws in their V90 OSW turbine nearly bankrupted Vestas. And that was just a 3MW fixed-bottom turbine in shallow seas, not a 15-18MW floating turbine in the harsh environment of the North Sea with mean wind speeds well above 10 m/s. Avoiding unanticipated flaws and defects making it through to serial production will be critical to building and maintaining a successful floating offshore wind sector in the UK.

The UK already has the basis for a strong national supply chain. Investment in floating offshore wind demonstration facilities such as proposed by EMEC will help de-risk home deployed projects, increase the UK's clean technology competitiveness and commercialisation capabilities, and secure UK exports and quality jobs.

There would be significant potential for the proving of technologies and techniques applicable to fixed-bottom wind as well. Both sites offer the opportunity to test new operations and maintenance technologies and practices as well, and, given the exposed location, there will be more regular opportunities to test in more challenging conditions, meaning faster speed-to-market for Scottish companies.

Fundamentally, it is anticipated that if a technology or innovation is proven west of Orkney, they should be deployable around the rest of the world without requiring further location-specific testing – a potentially massive commercial advantage for export-focussed Scottish companies testing at EMEC.

Doing such testing in Orkney – situated as it is in an exposed and representative location in the midst of the ScotWind projects - and avoiding Scottish companies having to use less representative overseas facilities for their testing and de-risking - helps ensure the fastest possible progression to market-readiness for Scottish supply chain companies, and that fewest possible defects make it through to serial production and subsequent deployment offshore, where rectification would be challenging, time-consuming, expensive and reputationally damaging.

EMEC economic impact

As regards developing the necessary indigenous supply chain, EMEC presents below compelling statistics demonstrating the significant impact of the company's technology demonstration facilities for wave, tidal and green hydrogen energy systems. The following points taken from EMEC's Economic Impact Assessment highlight the benefit and return on investment to regional and national economies of the organization:

- The economic impact assessment found that the creation of EMEC, and subsequent activities that have burgeoned since, has amounted to £370 million gross value add (GVA) to the UK economy between 2003 and 2023. £263 million of that was accrued in Scotland; and half of that, £130 million, in the Orkney Islands where EMEC is headquartered.
- To date £42 million public funding has been invested in the centre by public sector organisations, thus over £8 has been accrued for every £1 spent by the public purse. EMEC has created highly skilled, high value jobs and is now one of the top 20

employers in Orkney. The number of people directly employed increased from 44 to 85 between 2017 and 2023, with average earnings higher than the Orkney average.

- Since 2016, EMEC has diversified and grown its operations with support from competitively won grant-funded projects. EMEC has secured £49.5 million of research and development funding since 2016, taking part in R&D projects totalling £538 million for the development of the renewable industry. EMEC is fundamental in supporting industry to commercialise new technology, reduce risk, cut costs and improve efficiency.

EMEC's innovation expertise has also expanded into exporting consultancy services globally, with contracts in China, South Korea and the US, further facilitating the development of a global export market.

Lastly, EMEC's experience is that it is necessary to assist and enable vessel owners to be local. Orcadian companies like Leask and Green Marine should be encouraged to grow and retain local ownership, not sell out to big operators – who are generally not UK-owned. This will require a more nationalistic approach to support schemes.

7. What more can be done to support the development of sustainable, high quality and local jobs opportunities across the breadth of Scotland as part of the energy transition?

Generally, operations and maintenance skills need to exist in a particular place for the planned renewables deployment in said place. This is particularly relevant for island communities where the installation of energy technologies at individual household or community level could come with high wait periods and high cost if appropriate support network is not available.

Providing funding to businesses in 'Green space' to take on extra employees as part of training and supply chain support (the opposite to furlough where we paid people to not go to work) could help bolster training and upskilling opportunities.

The Offshore Renewable Energy Catapult (ORE Catapult) has estimated that the tidal stream industry has the potential to support almost 4,000 jobs in the UK by 2030. Combined with wave, marine energy could support more than 22,000 jobs in the UK by 2040.

The response to questions 11 and 12, and the recommended actions, set out how these jobs can be created and supported in Scotland.

8. What further advice or support is required to help individuals of all ages and, in particular, individuals who are currently under-represented in the industry enter into or progress in green energy jobs?

In consulting EMEC staff on this question, a range of responses were submitted including:

- Training opportunities: scholarships, apprenticeships, upskilling in carbon literacy, contractors/trade skills for new technologies.
- Experience through doing – practical and hands-on.
- Affordable housing (a particular challenge in Orkney and the wider Highlands & Islands region).
- Childcare to ensure all have opportunities to work.

- Representation – we aim for roles we see others like ourselves in – connect this with young people and diversity.

Chapter 3: Energy supply

Scaling up renewable energy

9. Should the Scottish Government set an increased ambition for offshore wind deployment in Scotland by 2030? If so, what level should the ambition be set at? Please explain your views.

No. The market will already struggle to deliver the present plans for offshore wind in the approximately 2500 days to 2030.

10.Should the Scottish Government set an ambition for offshore wind deployment in Scotland by 2045? If so, what level should the ambition be set at? Please explain your views.

Yes. Rounds beyond Scotwind need to be in preparation, however this needs to be strategic. There will be greater advantages to Scotland through the establishment of an enduring supply chain than there will from a 'gold rush' approach.

Targets for 2045 should therefore be matters of public discourse.

11.Should the Scottish Government set an ambition for marine energy and, if so, what would be an appropriate ambition? Please explain your views.

Yes, EMEC and the MEC strongly support the Scottish Government setting an ambition for marine energy. Any ambition should be matched with a clear pathway for delivery supported by an enabling policy and regulatory environment. The Strategy, and marine energy pathway, should make a clear distinction between the devolved powers that the Scottish Government can take, and the interventions that are required by the UK Government.

Tidal stream energy (TSE) and wave energy face similar but distinct challenges and are at different levels of maturity. As such we believe that two deployment pathways should be set out in the final Energy Strategy and Just Transition Plan.

The industry would welcome further consultation and consideration of an appropriate ambition for 2045. This long-term view will provide guidance to key bodies including the Crown Estate Scotland, Ofgem, transmission and distribution network operators, as well as providing certainty to investors.

The Resolution Foundation in its "Economy 2030" report notes that technologies like tidal "are not only likely to generate relatively high national economic returns, but also have the potential to contribute to regionally balanced growth"[6]. Investment in wave and tidal technologies in less innovation-intense regions generate strong returns, imperative for a just net zero transition.

[6] Resolution Foundation (2022) The Economy 2030 Inquiry, available online.

The below ambitions should inform and be included as part of the Scottish Government's deployment pathway for TSE and wave energy.

TSE ambitions

We strongly support the Scottish Government setting ambitions of:

- 200MW by 2030; and
- 700MW by 2035.
- Investing in the Scottish supply chain to create export opportunities.
- Increase R&D spend on TSE.

The draft marine vision is right to highlight significant industrial opportunity, and the unique role that TSE can provide in its predictability. Committing to the above ambitions will position Scotland to maintain its first mover-advantage, attract companies, investment, and green jobs across Scotland.

The TSE ringfence in Allocation Round 4 (AR4) will deliver significant benefit to Scotland with three projects delivering over 35MW of TSE capacity. It is crucial to delivery of the above ambitions that the ringfence is maintained, and the sector has clarity and consistency to support its growth. Ideally, the ringfence should be returned to £20m for future rounds or increased to support the sector scaling up.

The Policy and Innovation Group from the University of Edinburgh recently estimated that TSE could provide between £5bn and £17bn GVA to the UK economy by 2050. The aim of the Scottish Government should be to seize as much of this potential as possible[7], and to embed supply chains in and across Scotland, building on the success and very high Scottish content of world-leading developers like Nova Innovation and Orbital.

Scottish-based companies including Proteus Marine Renewables and Nova Innovation are already exporting goods and services to the global TSE market, with a strong potential to scale up these exports in coming years. This approach seeks to emulate the success of the Danish wind energy sector, which built a strong domestic market and supply chain through investment in projects in Denmark in the 1980s and used this as the foundation to export technology and services to the world. By 2003, 90% of Danish wind turbine production was exported, and Danish wind sector exports in 2019 amounted to €9 billion[8].

The Draft Energy Strategy and Just Transition aims to position Scotland as an international leader within the net zero transition to create and provide high-quality jobs with economic benefit. The UK and Scotland has an opportunity to create over 4,000 jobs in tidal stream alone by 2030 with a significant amount of the economic benefit expected to be generated in coastal areas (50-60%)[9].

TSE is on a clear cost-reduction trajectory as taken by wind and solar. TSE is projected to reach £78/MWh by 1GW of deployment, and below £50MWh by 2050 and 10GW of deployment.[10] This means that by 2035 TSE could be cheaper than new nuclear, and that support for TSE will be consistent with the Draft Energy Strategy and Just Transition's aim to deliver affordable energy whilst supporting economic growth.

[7] ORE Catapult (2022) *Cost reduction pathway of tidal stream energy in the UK and France*. Available online.
[8] https://stateofgreen.com/en/news/danish-exports-of-green-technology-increased-by-billions-in-2019/
[9] ORE Catapult (2018) Ibid.
[10] ORE Catapult (2022) *Cost reduction pathway of tidal stream energy in the UK and France*. Available online.

Wave energy ambitions

Scotland should set the following wave energy ambitions:

- 1MW to be deployed by 2027
- 200MW to be deployed by 2035
- Delivery of a co-location wave and wind pilot by 2030
- Maintain support for WES

We support the Scottish Government's ambition to deploy 4 x 250 kW wave machines at EMEC by 2027. This is an important target that provides clarity of direction to the sector. It should be noted that Horizon Europe is aiming to secure a 2MW (minimum) wave energy array, with €40M funding available to support two such projects. It is critical therefore that the 250kW x4 ambition is realised to keep Scotland competitive with developments at an EU-level. As with the ambitions set for TSE this should be matched with a clear pathway with points for review and re-evaluation if the Scottish Government and industry are not on track to deliver.

The 2027 ambition will be key in supporting investor confidence and signalling the Scottish Government's support for a key emerging renewable technology. The wave energy pathway should include the key sites which will be supported to develop to realise the Scottish Government's ambitions.

The deployment of an initial array should support the route to realising 20MW of wave energy deployed in Scotland by 2035. Depending on developments in the industry this could be scaled up and should be kept under review if the industry is able to respond to a greater ambition.

Diversity and innovative deployment of renewable technologies will be key in optimising how the energy system is utilised. Waves provide a more consistent generation profile than wind 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 14%.[11] The UK Government is currently undertaking its Review of Electricity Market Arrangements consultation, which may lead to a more efficient use of existing infrastructure having greater value than in existing arrangements.

Committing to a pilot project as a step toward commercialisation will position Scotland to be a world-leader in innovative offshore renewable deployment.

Finally, grant (R&D) support has been - and will continue to be - crucial in enabling further step-change technology cost reductions, with significant impact on overall learning investment to reach competitive LCOE. A 2021 paper by Kerr et al.[12] suggests that a 10% step-change cost reduction can reduce overall learning investment by approximately a third on the road to achieving target LCOE.

EMEC would add a word of warning: marine energy will need to see a step change in the approach government takes to support decarbonising technologies for the above to be delivered. Targets without full and effective support will be little more than wishes.

[12] P. Kerr et al. (2021) – Implementing Radical Innovation in Renewable Energy Experience Curves. *Energies,* 14(9), 2364. [Available here: https://www.mdpi.com/1996-1073/14/9/2364]

The marine energy industry is committed to trying to deliver against these targets, but Government should be under no illusion as to how hard this will be and how industry will need Government's full and unwavering support to deliver.

The change in attitude in the USA through the Inflation Reduction Act needs to be matched in the UK and many of the present strictures relating to 'State Aid' restrictions need to be challenged and set aside in the drive we now need to effectively decarbonise.

12.What should be the priority actions for the Scottish Government and its agencies to build on the achievements to date of Scotland's wave and tidal energy sector?

EMEC echoes the views compiled by the UK MEC. It proposes the following wider actions to build on the sector's achievements and maintain its world-leadership in MRE deployment:

Provide clarity to industry and investors

- **Action 1: The Scottish Government should set out two distinct deployment pathways as part of any finalised strategy.**

As noted, wave energy and tidal stream are distinct technologies and should have separate deployment pathways in the finalised strategy. This will allow for Scottish Government actions, and engagement with the UK Government and other bodies, to be focused accordingly.

These two deployment pathways can be included in a Marine Energy Action Plan, which could be developed as a distinct piece of work from the ESJTP and marine vision.

- **Action 2: Demonstrate intent in setting achievable and impactful MRE deployment ambitions.**

In question 11 we set out what we think these ambitions should be. These ambitions should be supported by a clear pathway for delivery.

- **Action 3: Engage with the UK Government on its non-price criteria consultation and the future of the CfD.**

The current CfD mechanism awards contracts based on the lowest Levelised Cost of Energy (LCOE). This has been successful in increasing renewable capacity from 7% of the UK's electricity supply in 2010, to over 40% today. However, a great deal of the cost-reduction achieved was because of other countries supporting indigenous renewable sectors and supply chains. These countries are now benefiting from thriving export markets.

In the 1980s Denmark invested heavily in wind, delivering projects with high levels of local content, and developing its domestic market. In the process it gained first mover advantage and in exports alone its wind sector generates over £7bn annually for the Danish economy. In 2012, 88% of Denmark's exports were associated with tidal turbines and components.[13] By contrast the UK's wind sector, Europe's largest generator of wind energy, exports less than £0.5bn annually and is a net importer of wind technology, principally from Denmark.[14]

[13] Deloitte (2012), *Study of the macroeconomic impact of Wind Energy in Denmark*
[14] State of Green (2021) *The economic benefits of wind energy*. Available online.

Both tidal stream and wave energy will be cheaper than new nuclear at 1GW of deployment.[15] However, these technologies are not going to be the cheapest to deploy in the short term.

Research by the University of Edinburgh through Project EVOLVE has found that deployment of just under 13GW of marine energy will reduce annual dispatch cost from £13.54bn to £12.51bn. This is a saving of £1.03bn annually for UK and Scottish households. This cost reduction comes from a higher dispatch of renewable energy – by up to 27 TWh (+6%), and thus a lower requirement for expensive peaking generation – by as much as 24 TWh (-16%) when wave and tidal generation are part of the electricity mix, compared with a scenario without marine energy generation.[16]

The UK Government's non-price criteria consultation provides an opportunity to include considerations around supply chain development, local jobs being created and supported, and in delivering a diverse renewable energy generation portfolio, key to energy security. As the CfD will likely be the primary mechanism for renewable deployment for the foreseeable future, it is key that the Scottish Government engages, and that the benefit of MRE is accurately factored into future considerations.

- **Action 4: maintain the Scottish Marine Energy Industry Working Group**

This industry working group has been a key driver in identifying barriers and proposing solutions to increasing MRE deployment. Internationally Scotland and the UK is at risk of being left behind as countries seek to establish first-mover advantage in emerging technologies. The United States' Inflation Reduction Act is already pulling investment and supply chains from the UK[17] and is making over $1.7bn available to marine projects.[18]

The MEC believes the next iteration of the SMEIG should be ministerial-led, and support Scotland taking a strategic approach to MRE deployment and in responding to changes and challenges internationally. It could also have a role in monitoring industry progress on the TSE and wave energy deployment pathways, and horizon scan for any challenges in delivery.

Make Scotland the most attractive country to invest in marine renewable energy.

- **Action 5: Increase innovation, research and development support for MRE.**

Innovation and demonstration projects will be crucial in developing the MRE industry. Innovation funding is crucial to expected reductions in the strike price. However, limited innovation support or demonstration programmes are available for MRE in the UK, and ongoing uncertainty around UK participation in the Horizon programme is damaging.

Almost all recent MRE funding in the UK has come from the EU, except for Wave Energy Scotland (WES) and the Saltire Fund. While the Scottish Government should be commended for this support, we as a sector believe the Government could go further. Over a 3-year period the European Commission allocated over €160m to the sector. In comparison the sector has received £30m from the Scottish Government over the past six years.

[15] Catapult (2018) Ibid.
[16] Supergen (2023) *What are the UK power system benefits from deployments of wave and tidal stream generation?* Available online.
[17] The Times (2023) *Biden's green subsidies could lure gigafactory away from Dundee.* Available online.
[18] US Government (2023) *Building a Clean Energy Economy: A guidebook to the inflation reduction act's investments in clean energy and climate action.* Available online.

As the sector moves from projects in the single digits towards economies of scale, business as usual for innovation funding will no longer be sufficient. This issue could be compounded by the as-yet-undetermined future of European funding in the UK, which may no longer be accessible to Scottish projects in the near future. Specific funding must therefore be made available to maintain Scotland's global lead and to achieve the expected reduction in LCOE.

Innovation funding is required at both the Scottish and UK levels, and we encourage the Scottish Government to consider how best to provide its own support while encouraging the UK Government to do the same. Funding through Innovate UK would greatly support the sector and depending on the availability of European funding, might be a critical lifeline. The Scottish Government can lobby UK Government for such funding, and the Enterprise Agencies can support Scottish companies in accessing it.

Research by the University of Edinburgh has revealed that between 2017-2022 wave energy received £39m funding (with WES accounting for £35m of that total) and TSE only £15m. This is significantly less than other renewable and emerging technologies and should be addressed within the Scottish Government's Just Transition Strategy.[19]

- **Action 6: introduction of a support mechanism for off-grid markets**

Marine renewables are strongly positioned to support the decarbonisation of offshore activity. This is being demonstrated by Mocean's Renewables for Subsea Power (RSP) project. The £2million demonstrator project, called Renewables for Subsea Power (RSP), has connected Mocean's Blue X wave energy converter with a Halo underwater battery developed by Aberdeen intelligent energy management specialists Verlume.

The two technologies have been deployed in March 2023 will provide low carbon power and communication to infrastructure including Baker Hughes' subsea controls equipment and a resident underwater autonomous vehicle provided by Transmark Subsea.

The project aims to show how green technologies can be combined to provide reliable low carbon power and communications to subsea equipment, offering a cost-effective alternative to umbilical cables, which are carbon intensive with long lead times to procure and install.

Alternative markets also apply to tidal power, which could potentially be used as a reliable source of supply for hydrogen production, or to decarbonise industry. For example, Nova Innovation's Oran na Mara project in the Sound of Islay has the potential to provide predictable, renewable power to Scotland's whisky islands of Islay and Jura, offering a net zero solution to one of Scotland's most important industrial sectors.

The Scottish Government should explore ways to support projects that have developed beyond the pilot project stage but have a different application to that addressed by the UK Government's CfD mechanism.

- **Action 7: Ensure infrastructure is prepared for renewable deployment.**

The MEC recommends that the Scottish Government should support the national port and harbours infrastructure as well as targeted manufacturing, supply chain and skills development to ensure that Scottish companies winning CFD projects can achieve 70%

[19] Supergen (2023) *What is the Optimal Balance of Development and Deployment Policy Support Mechanisms for Wave and Tidal Power?*

Scottish content in their project supply chains. This will also enable both increased GVA and jobs to Scottish organisations from both domestic and export sales.

Make it easier to get technology in the water.

- **Action 8: reduce the consent timescales to enable MRE deployment at pace.**

The Scottish Government should streamline regulation and enable synergies between marine and other developments. We recommend reducing consenting review approval times to three months, as is being pursued for offshore wind in the UK. This is in line with current proposals by the European Commission across Europe and will strengthen the project pipeline and ensure that Scotland remains at the forefront of new project development.

MRE projects can be deployed within well under 3 years. However, due to current consenting constraints and the structure the primary mechanism for supporting renewable projects, the CfD, development of a new, greenfield site takes upwards of 7 years – and potentially much longer. New site development is crucial to the future growth of the industry and the achievement of the goals set out above, but the extremely long timescales involved are a strong disincentive to investment. The fact that very few new sites are under development in Scotland is testament to the fact that the existing regime needs to change, and development timescales need to be accelerated.
The Scottish Government could explore aligning offshore consents with onshore consents, which only require a Section 36 consent for projects over 50MW, offshore projects require a consent for projects over 1MW. A proportionate approach to consenting is also required, where relatively small-scale marine energy developments can be assessed more quickly than multi-GW offshore wind farms. In addition, designating key areas as strategically important for energy security could enable rapid and streamlined consents. It should be acknowledged that no negative impact on marine mammals has been recorded at key Scottish sites including EMEC, MeyGen and the Shetland Tidal Array.

- **Action 9: work with the sector to reduce the costs and liabilities associated with deploying MRE technologies.**

The Scottish Government should work with Westminster to revisit current arrangements around decommissioning bonds. Currently large projects are typically asked to set aside millions of pounds for decommissioning, provided up-front and held in real cash terms. In contrast, large offshore wind projects only require a paper bond which states there is enough cash for decommissioning, and the value of this bond can build up in value during the life of the project (mid-life accrual). An equivalent product is not available from the bond market for tidal stream energy. This is a market failure, caused in part by a line in the Decommissioning Act, that allows the UK Government's Secretary of State to call in the bond even in the absence of an event that would require the bond to be called upon. This can be quickly addressed through an amendment which allows novel and innovative generation projects to have a bond called in only if the bond is required and following appropriate events. This will remove a significant barrier for tidal stream and wave energy projects. The Scottish Government should join industry in advocating for this change, and in supporting mid-life accrual of decommissioning securities for marine energy projects.

Equally the industry faces significant headwinds around insurance which increases the cost of deployment. The first deployments of tidal stream or wave energy projects invariably come with higher risks and therefore higher financing costs. Offshore wind has proven that financing costs can be dramatically reduced over a very short space of time. Currently insurance costs

are a significant and costly barrier to marine renewable deployment. In the absence of competitive commercial insurance options, the Scottish Government should explore the proposal being developed by Renewable Risk Advisers, to introduce an 'Insurance and Warranty' Fund. This is an insurance service for early pilot farms designed to balance the interests and incentives of public authorities, ocean energy developers, and investors. As well as directly reducing the costs of the first deployments, the Fund will generate data to 'crowd in' commercial insurers, and ultimately put itself out of business.[20] As part of deploying renewable technology at pace the Government should consider support for this proposal and similar financial measures to de-risk early project development.

- **Action 10: Continue to provide cornerstone debt finance for MRE projects.**

We recommend that the Scottish National Investment Bank continues to provide cornerstone debt finance to early-stage MRE projects to leverage additional private sector finances. This will help to reduce the cost of capital and make early, but commercially fundable projects more attractive to inward investors. These projects should be focused on maintaining Scotland's global lead by deploying capacity in the water and consolidating and expanding Scotland's world leading MRE companies and supply chain.

In addition to these industry wide points EMEC would further offer the following specific comments:

EMEC was established to facilitate real world testing of commercial scale tidal and wave energy devices and over the last 20 years and has supported the deployment of over 30 devices in waters off Orkney. Over this time EMEC has developed world leading experience and skills in the sector and is well placed to support the technology as it scales up to arrays.

EMEC is seeking to expand its tidal test and demonstration facility which will:

- Deliver £300M+ supply chain opportunity in a key target sector for Scotland
- Facilitate the next steps in scaling up the sector at an ideal site location for testing pre-commercial arrays, with vastly superior resource to alternatives in England and Wales
- Support Scottish technology companies to increase scale and reduce cost, and attract inward investment via global developers
- Secure Scotland's position as world-leading
- Capitalise upon the £300M+ Orkney grid upgrade in 2027/28

The Fall of Warness tidal site off Eday is an excellent location for this, allowing developers to move from the testing of individual devices to arrays in familiar waters and drawing on an established supply chain and network of services before moving on to larger projects elsewhere.

Market demand for this has been strong, therefore EMEC has already committed to development work including site surveys, consenting, progressing the grid connection and actively engaging with key stakeholders.

In addition to securing consenting and lease rights, EMEC proposes to also develop the required infrastructure to provide a 'route to market' for these pre-commercial arrays, in a similar manner to the work done previously for individual device testing. A proposal is being presenting to Scottish Government outlining these aspirations in more detail.

[20] OceanSET (2021) *Design Options for an Insurance and Warranty Fund*. Available online.

Finally: The Scottish Government should explore a market mechanism for projects that have developed beyond the pilot project stage but have a different application to one sought by the UK Government's CfD mechanism. At present this scale of endeavour is ineligible for CfD support and this is impeding further market entrants.

14.In line with the growth ambitions set out in this Strategy, how can all the renewable energy sectors above maximise the economic and social benefits flowing to local communities?

Scotland has existing strategic advantages in marine energy. As noted coastal communities will benefit significantly from support for the sector, and that marine energy strongly aligns with aims of attracting investment in post-industrial communities.

According to research, TSE projects deliver around 76 full time equivalent jobs during a project's construction, and 5.5 jobs for each MW and year during operation[21]. As noted in the draft strategy, key sites like Nova Innovation's Shetland Tidal Array and the European Marine Energy Centre have already delivered significant local benefit (see EMEC Economic Impact in Question 6 above).

These benefits are as a direct result of the drive shown early in the century to establish this world lead. EMEC strongly welcomes the intent shown by the Strategy to do more and do it across more fields. EMEC would naturally be willing to bring its experiences to the new endeavour. However, EMEC would offer the observation that the drive shown that brought EMEC into existence has been less apparent in recent years. EMEC would suggest that there will need to be a dramatic increase in effort by all parts of Scottish society and government to achieve the ambitions in the document, and that increase in effort needs to start immediately.

Floating Offshore Wind demonstration

Floating wind has the potential to be undertaken extensively in Scotland, or else just imported. EMEC strongly advises that the former will deliver Scottish Communities the greatest benefit.

EMEC has been working with industry and local stakeholders to establish whether there is demand for a floating offshore wind test site in deep water to the west of Orkney.

With the announcement of more than 20GW of floating wind in recent and announced seabed leasing rounds in Scottish Waters and the Celtic Sea, and at least the same again already being mooted for subsequent rounds, the need for such a facility is now demonstrably clear.

Industry itself supports our belief that a test and demonstration facility such as EMEC is proposing – and particularly one that is firmly within such an energetic and challenging environment that technologies tested can be proven for deployment worldwide - should be available to UK project and technology developers.

With exactly these challenging wind and wave conditions at a site 15km to the west of the existing Billia Croo wave test site – and that are not available at any existing or proposed test and demonstration site elsewhere in UK waters – this site should be developed, owned, and operated by EMEC as a key National Laboratory for the UK, and for the benefit of developers

[21] https://element-project.eu/wp-content/uploads/2020/04/ELEMENT-Socioeconomic-Analysis-Plan-IDETA-INNOSEA.pdf

who wish to develop, test, prove and deploy their technologies in both Scottish waters and globally.

Though it might become a significant generator in Orkney when these projects are energised and generating at max., EMEC will not by itself significantly move the dial on delivery of national net zero commitments for Scotland. That said, by providing world-class test, demonstration and proving infrastructure for others, it will enable and 'unlock' significant progress in this regard by others, including a level of proving that means products and technologies tested in Scotland can be readily and confidently be deployed all around the world.

EMEC would be happy to have discussions with the Scottish Government and other stakeholders as to how to make this a reality and would welcome the opportunity to meet to discuss our views further.

More widely

It appears that neither the social nor energy system benefit of marine energy are accurately valued by the UK Government. The Scottish Government should engage with Westminster to support the industry's asks as part of the Non-Price Factors consultation presently underway.

15.Our ambition for at least 5 GW of hydrogen production by 2030 and 25 GW by 2045 in Scotland demonstrates the potential for this market. Given the rapid evolution of this sector, what steps should be taken to maximise delivery of this ambition?

It is critical that hydrogen is used in the right way. As an early adopter and promoter of the use of hydrogen as an energy vector EMEC's views have evolved based on its experience over the last 7 or so years of working in this sector.

Firstly, it needs to be recognised that hydrogen is a difficult material to handle safely. Its tendency to escape demands extremely high standards of workmanship, standards that EMEC has found it a challenge to secure.

Secondly, the storage of hydrogen is not straightforward at scale. EMEC has successfully stored and transported small volumes but can see multiple challenges with scaling this up.

The result of these experiences is that EMEC now firmly believes that there will be a significant need to bond hydrogen to other materials as soon as possible in order to minimise the challenges.

In 2021 EMEC hosted the demonstration by Zero Petroleum of the manufacture of synthetic hydrocarbons from EMEC's electrolytically produced hydrogen. This 'efuel' was much easier to handle than hydrogen and so overcame the problems outlined above. The fuel was used by the RAF in their first ever fully synthetically fuelled flight[22].

EMEC believes that the combination of this technology, along with the direct air capture of carbon from the atmosphere, will provide a major route to market for the energy about to be derived from renewables and turned into hydrogen.

[22] A Net Zero RAF by 2040 | Royal Air Force (mod.uk)

EMEC regards it as essential that this route to market is thoroughly, urgently and extensively explored. It is entirely possible that EMEC is wrong on this matter and there are unforeseen problems, however at present there is little empirical evidence and it would be imprudent to over commit to any one course of action.

Returning to EMEC's position as an early adopter, this 'have a go' approach to testing ideas has been reasonably successful. However, it should be realised that it has been undertaken on the back of other R&D. Had it not been for the fact that there was successful generation of tidal energy into a constrained grid then the need to explore other energy vectors would not have been present. EMEC would therefore not have had to look at hydrogen. The point being made is that innovation leads to innovation and Scotland should commit to strongly support the fossil free energy sectors' R&D needs, especially at the practical demonstration stages. EMEC would strongly support the production of an overarching R&D strategy for the renewables sector and would be glad to play a part in its drafting.

The other side to the hydrogen story is how business can be encouraged to be involved. Extensive and detailed work has been undertaken in Westminster over 'hydrogen business models', but these have become abstruse and complex.

Returning to the 'Have a go' model, EMEC would strongly urge that more effort is dedicated to attracting business to actively participate and though that activity solutions will be found. For this to happen it will be essential that business is confident to commit time and resources and it is an unavoidable conclusion that they will do this if it is in their financial interest. EMEC has observed that big business is often extremely risk averse and given their other priorities they seem to find it hard to commit to early action.

It is EMEC's opinion that the 'fire-power' of business needs to be deployed onto the presently intractable challenges and for that to happen Government will need to find better ways to incentivise business to engage. To be frank this will mean Government putting more money on the table earlier to drive that engagement.

EMEC would also offer a further observation: it is essential that money is committed to driving activity and not to reducing cost. Cost is, to a large extent, derived from past experience. An experienced operator will be faster, better organised and have the right tools for any job. These attributes allow jobs to be undertaken at lower cost and more effectively. That experience is only built up from repeated actions.

EMEC would warn against an obsession with cost reduction for early activity as such a focus delays deployment. EMEC has seen this in the marine sector and is fearful it is also playing out in offshore wind through the CfD. EMEC would strongly advise that progress towards the 5GW target will be slower if there is an over concentration on cost. The progress will be faster if it is directed towards activity.

Finally, EMEC would also stress that some of what will be undertaken will be wrong and Government needs to be ready to recognise that direction may need to change based on experiences gained. Using EMEC's local experience as examples, work was done on the use of hydrogen fuel cell vehicles in Orkney. During the period of the trials there has been so much progress with battery technology that the benefits of hydrogen now appear marginal.

This sort of 'learning by doing' is going to be an inevitable result of seeking to make the revolutionary progress the nation is going to have to make to decarbonise.

16.What further government action is needed to drive the pace of renewable hydrogen development in Scotland?

See above.

EMEC regards it as essential that action can be undertaken faster and more effectively if budgets are increased and also that the strictures of State Aid are challenged and altered. If the UK intends to be a successful supplier to the world of innovations, then these need to be actively encouraged.

North Sea Oil and Gas

20.Should a rigorous Climate Compatibility Checkpoint (CCC) test be used as part of the process to determine whether or not to allow new oil and gas production?

Yes. EMEC recognises the importance of fossil fuels to the present UK economy but believes that the burning of fossil fuels must be brought to a halt as soon as possible if catastrophic climate change is to be avoided. Fossil fuels must be replaced by renewables at the greatest speed possible.

The tensions and challenges of such a fundamental change in the planet's energy system are recognised, however EMEC sees no value in delaying the fastest possible deployment of renewables possible. It is also recognised that there is considerable reluctance to make that change but change we must.

EMEC would therefore strongly support measures which include climate justice considerations for people across the world, future generations and ecosystems.

21.If you <u>do</u> think a CCC test should be applied to new production, should that test be applied both to exploration and to fields already consented but not yet in production, as proposed in the strategy?

EMEC has not seen evidence that would suggest there is time to allow existing fossil fuel reserves to be exhausted before change is implemented. It would therefore appear that assessment should be undertaken of all fossil fuel production plans, not just new ones.

25.Should there be a presumption against new exploration for oil and gas?

Yes.

Oil and gas extraction for non-fuel purposes and which do not give rise to climate damaging emissions need not be curtailed.

Chapter 4: Energy demand

Heat in Buildings

27.What further government action is needed to drive energy efficiency and zero emissions heat deployment across Scotland?

An unrelenting pressure on energy efficiency is essential if Scotland is to both meet its emissions targets, but also in order to make the most of the renewable resources it has. In simple terms, Scotland can either use all its renewables itself or if it can be more efficient then it could halve its energy requirements and have the other half to sell.

EMEC does not believe that it will ever be efficient to supply hydrogen to buildings for the purposes of heating. EMEC is involved in the commissioning of a CHP plant at Kirkwall airport and believe there may well be limited locations where this sort of technology can be deployed.

EMEC also notes the excellent work done locally by Orkney Islands Council in the installation of sea-source heat pumps in Stromness. This is part of the portfolio of work done on new buildings in the county that have used a variety of heat pumps and OIC's experience should be more widely used and known about.

Energy for transport

28.What changes to the energy system, if any, will be required to decarbonise transport?

Different transport modes will require different solutions, but EMEC's experience shows that some elements are easily resolved;

Road transport

EVs work. EMEC has had EVs for 8 years as company vehicles and many staff have now made the switch. Most charging is done at home and work-based chargers are useful if only sporadically used as a last resort. As mentioned elsewhere EMEC therefore does not see a role for hydrogen in the majority of light transport.

Electric vans are starting to appear, and small HGVs will inevitably appear soon alongside buses and coaches. It would appear that Scotland is broadly on the right track with this.

Assuming all the above are electric then this will present an additional amount of energy to be delivered over sections of the electrical network. However, if managed smartly this may not present much of a change to the network itself. EMEC's experience as a partner in the UKRI funded ReFLEX project was that the systematic charging of vehicles (at times of high renewables availability) can be undertaken, but that it is presently complex and unwieldy. More work will be needed to better integrate vehicles into the network rather than them be seen as just users of it.

Aircraft

EMEC's experience with hydrogen has led it to the position as detailed in Q15 where it is now firmly of the opinion that the majority of flight will be undertaken using efuels, specifically synthetic kerosene made form electrolytic hydrogen and direct air captured carbon.

There may well be a market segment for electric aviation and the experience of battery improvements taking over the niche that was being ear-marked for hydrogen cars and vans

should be borne in mind. The likely ubiquity of efuels may well crowd out battery passenger aircraft.

Ferries

To become more efficient, it is essential that all aspects of energy use are considered. Of specific local interest is the energy efficiency of ferries which are considerable energy users. By way of context; the ferries that come from Aberdeen to Orkney use as much electricity as Orkney (~22MW).

The displacement hulls favoured by CalMac on the majority of Scottish ferry routes are extremely energy inefficient when compared to modern hull configurations such as medium speed catamarans. It will be interesting to see the results of the present CalMac trials of the MV Alfred in the Western Isles due to its much lower fuel requirements. This is because the options to decarbonise shipping will be dramatically increased if fuel efficiency leads to lower energy requirements. i.e. it will he half as hard to make the synthetic fuels or supply the electricity if the final vessel only uses half the energy of today.

It is possible that ferries that are incapable of being fully electrified may well use the same e-fuels produced for aviation. Other fuels are also being considered for shipping and Scotland should make sure it is ready to both adopt the best, but also to seek to play a leading role in the provision of that fuel from its abundant renewable resources.

29.If further investment in the energy system is required to make the changes needed to support decarbonising the transport system in Scotland, how should this be paid for?

As outlined above, EMEC is firmly of the opinion that part of the decarbonisation of transport will be through electrification and part though efuels. The balance of this split is as yet unknown, however it is important that it is determined as soon as possible. This will therefore enable the appropriate 'balance of plant' to be determined. i.e. will there need to be high-voltage transmission cables or pipelines laid from the source to the user?

As the picture of this new energy system emerges, so the business models for its deployment will similarly emerge.

It is likely that many solutions will be comparatively capital intense and so governmental assistance with capital and potential revenue support will be essential if the 'social good' of decarbonisation is to be delivered in time.

30.What can the Scottish Government do to increase the sustainable domestic production and use of low carbon fuels across all modes of transport?

The demonstration of efuels needs to be urgently scaled up and EMEC is making proposals to Scottish Government for a programme of such work.

The exploration of the fuels eco-system needs to be undertaken and frequently refreshed as solutions are proven and the outcome of experiments become available. The map of this eco-system is still incomplete and the specific points on it are still unexplored.

EMEC would urge that Scottish Government continues the open dialogue with the developing sector and continues to signal its clear support for innovation.

31.What changes, if any, do you think should be made to the current regulations and processes to help make it easier for organisations to install charging Infrastructure and hydrogen/low carbon fuel refuelling infrastructure?

EMEC's direct experience of seeing to install workplace EV chargers was that the anticipated Permitted Development Rights for such small scale infrastructure did not apply. PDR has rightly been introduced for small scale changes, but there is an overriding the carveout that means Permitted Development Rights don't apply in National Parks and National Scenic Areas. This appears to be an overly restrictive control and should be softened. In the case of Orkney, the entire west-coast is an NSA and therefore no houses in the West Mainland can install a shoe-boxed sized charger on properties without having to seek full planning permission. This needs removing.

Energy efficiency of buildings will need to be of equal importance (or greater) than historic conservation (double glazing/insulation etc.). Based on EMEC staff experience; this is far from the case at present.

32.What action can the Scottish Government take to ensure that the transition to a net zero transport system supports those least able to pay?

There is a risk that the benefits of the electrification of transport come last to those least able to afford it. This has been demonstrated by numerous case studies. Examples include Sovacool et al., (2019)[23]. Continued support for the capital cost of electric vehicles (private and public) will be necessary, but with a skewing to greatest social good.

Charging will continue to need support. In rural areas that may well be through the support of home charging, in urban areas through the availability of on-street/car court charging.

Ferry transport electrification should not be overlooked as an important opportunity to reduce running costs.

Energy for agriculture

35.What are the key actions you would like to see the Scottish Government take in the next 5 years to support the agricultural sector to decarbonise energy use?

EMEC has little direct experience in this area although the uncertainty as to the means by which transport will be decarbonised (EV or efuels) similarly applies to agricultural plant. It is likely that there will be significant electrification, but that heavy and intense uses (combines/plouging) may see divergence into efuel use. Pilots should be accommodated to determine the options and optimal solutions.

[23] Sovacool, Hook, Matiskainen, Baker (2019), *The whole systems energy injustice of four European low-carbon transitions*. Global Environmental Change, 58, 101958. Available at https://doi.org/10.1016/j.gloenvcha.2019.101958

Chapter 5: Creating the conditions for a net zero energy system

40.What additional action could the Scottish Government or UK Government take to support security of supply in a net zero energy system?

As noted in our response to question 1, the MEC strongly supports delivery of a diverse energy generation portfolio to be an explicit aim of the Scottish Government's draft strategy. This is not only to seize opportunities associated with marine energy, but also to support a more secure energy system.

Modelling carried out by Research by Imperial College London shows that tidal stream can directly reduce natural gas capacity required to ensure energy security by about 40%.[24] As more than half of UK gas is imported, firmer power renewable energy resources like tidal stream will be key in supporting the UK's energy security, a cost-effective transition to net zero that protects UK households from international gas price shocks.[25]

The importance of a diverse generation mix was emphasised over a two-day period in 2022. The UK energy system saw a record-breaking day on 2 November as wind generation exceeded 20GW for the first time, beating the 19.93GW record set in October 2022, which itself broke the 19.91 GW record set in May of last year.

The following day wind generation fell below 2GW with the shortfall covered by interconnection and gas-fired power generation. Energy security in a net zero world requires a diverse energy generation portfolio, so when the wind isn't blowing, or the sun isn't shining the shortfall can be addressed by renewable and low-carbon options rather that fossil fuels.

The work of Project EVOLVE highlighting the ability of marine energy to deliver a more cost-effective energy system has already been set out in this response. In addition, research by the University of Plymouth has shown that tidal stream can reduce the power rating and energy storage capacity of inter-seasonal energy storage which will be a key driver of cost in the future energy system. [26] A reduction in required storage will make the UK's energy system more cost-effective and potentially secure.

To expedite progress towards net zero and energy security, EMEC has made several proposals for how the facilities in Orkney could be expanded by enlarging EMEC's tidal test site, and creating new floating offshore wind test facilities as key national infrastructures. Each of which unlock and enable the rapid but dependable growth of new and established Scottish companies in the sector.

EMEC is also involved in the use of batteries for the storage of tidal and wind energy to support the production of hydrogen. EMEC intend to continue to share its experience of the technology in order to help Scotland better understand the likely trade-offs and balance of plant decisions.

41.What other actions should the Scottish Government (or others) undertake to ensure our energy system is resilient to the impacts of climate change?

[24] Frost (2022) Quantifying the benefits of tidal stream energy to the wider UK energy system, available online.
[25] D. Pudjianto, G. Strbac (2022) *Role and Value of Tidal Stream Generation in the Future UK Energy Mix*.
[26] Coles et al (2022) *Impacts of tidal stream power on hybrid energy system performance: An Isle of Wight case study*. Available online.

Resilience

The existing electrical distribution system in Scotland relies upon overhead cables supported on wooden poles. The storms of 2022 showed the vulnerability of this when Aberdeenshire was without electricity for 10 days and water for 7. With increasing storminess resulting form climate change then this risk is increasing. In addition the general electrification of society will mean that a similar outage could also take out all heating and transport.

When EMEC installed its grid connection to Billia Croo in 2004 and its connection to Caldale on Eday in 2005 it took the precaution to underground the connections. This was fast and has proved reliable. EMEC therefore firmly believes that Scotland should seek to minimise its risk exposure to adverse weather conditions by undergrounding its present distribution network.

Storage

The storage of heat is grossly overlooked in Scotland. It is comparatively simple and inexpensive and as more of Scotland moves towards district heating powered by renewables, so the value of thermal storage will increase.

Efficiency

Scotland needs an unremitting campaign and action to reduce energy use. Its housing stock is not good and so the energy demand by the nation is unnecessarily high. This in turn means that more energy is needed to run the country than would otherwise be needed and so there is a greater risk exposure to failure from adverse weather.

Diversification

A diverse fossil free energy system will both reduce over dependence upon one source but will also provide Scotland with the flexibility to cope with change and the experience to profitably sell overseas.

Furthermore, the sooner the transition takes place, the lower the overall planetary risk of catastrophic climate change. Scotland should not be afraid to lead away from fossil fuels and should do this urgently and with confidence.

Chapter 6: Route map to 2045

42.Are there any changes you would make to the approach set out in this route map?

Not specifically and the map is welcome. It should be recognised that it will need frequent revision and details will need to be inked in based on experience.

43.What, if any, additional action could be taken to deliver the vision and ensure Scotland captures maximum social, economic and environmental benefits from the transition?

The Strategy took a long time to emerge from Government and Scotland cannot afford further delays. A general picking up of the pace of activity is needed across all sectors.

The measures outlined are broadly welcomed, but there is much to do and little time to accomplish it. EMEC would welcome the opportunity to more routinely participate in initiatives and it stands ready to play as full a part as it can.

Impact assessment questions

46. Is there any further action that we, or other organisations (please specify), can take to protect those on lower incomes or at risk of fuel poverty from any negative cost impact as a result of the net zero transition?

- When looking at engagement appendix P.158, from "Dumfries to Thurso": is this a figure of speech or was there engagement with island communities?
- It is important to take a needs-based and not a cost-based approach. In Orkney, households in most extreme fuel poverty are the most expensive to support (generally in the outer islands)[27]. Priority should be to support those in worst scenarios even if this entails fewer households are supported per investment.
- Electricity price increases – while encouraging communities to electrify, there is a need to urgently continue work with UK government to redesign the electricity market.
- While this question is about cost, there is a need to also consider adjacent distributional impacts. An example scenario would be the islands becoming an infrastructure powerhouse for renewable energy to feed energy needs and establish export opportunities for the nation, while continuing to live in very challenging energy situations (higher distribution costs, energy insecurity, high fuel poverty levels)
- There is a need to consider fit for purpose solutions. An example of this is that some rural/island households may become *more* energy insecure, or even fuel poor, from installing electrified solutions such as heat pumps, because break down could entail long wait periods for maintenance technicians to arrive etc., versus if these homes have access to heating systems based on peat or a generator to heat their homes. Approaches to address this could be allowing certain properties to have back-up forms of generation to account for weather and mechanical uncertainties, or to consider supply chain needs of particular locations. In any case, the government should not apply blanket policies to households in hard-to-reach locations.

47.Is there further action we can take to ensure the strategy best supports the development of more opportunities for young people?

The increase in attention on STEM subjects, specifically relating to renewables and decarbonisation is welcomed, however it is important to recognise that much of the change will be socially orientated as well as technically. It is important to ensure the 'social sciences' are mobilised to help deliver the transition.

There is already strong latent interest by the young in a sustainable future. This needs to be further fostered and supported in order to enable them to be ready and able to deliver much of the change.

[27] https://www.orkney.gov.uk/Files/Housing/Housing%20Options/Housing%20Strategy/Fuel_Poverty_Strategy.pdf , P.16

Just Transition energy outcomes

49.What are your views on the draft Just Transition outcomes for the Energy Strategy and Just Transition Plan?

Theme 1: Jobs, Skills and economic opportunities

- Good to see both quantity and quality mentioned (more and better jobs) – but need to also address inequalities and rooted biases in the current energy sector throughout. This is hinted at in the "access to jobs" point but would recommend explicit acknowledgement of this, alongside a plan in place to address this.

- E.g., P.91 "Workers, and trade unions, will be at heart of everything we do as we work on our just transition plans." This will not address issues where there may be deeply entrenched inequities in the energy sector today. It will be necessary to bring in people that are not part of this sector, and need to do so at the same level – gender, race, ethnicity, disability etc. If this is not done, then there is an increased risk of transposing inequities of the existing energy sector into the future workforce.

Theme 2: communities and places

- Energy production maximised as is community ownership: need to be careful with this phrasing. What does "maximised energy production" mean, is this community owned energy production, or energy production potential in general? Finally, a broader point to note that just because the energy resource *potential* is there does not mean it *needs* to be or should be produced. Trade-offs must be considered in terms of the places that will be industrialised and the impacts this could bring, versus the potential to legislate for and encourage reduced energy consumption. A level of ecosystem justice and awareness comes in here too – the "just because we can" approach historically taken by humans with regards to energy has proven unsustainable and unjust in the long run.

- Regarding community ownership, the government needs to ensure capability and capacity of communities that are being encouraged to own assets, so they are not burdened down the line. Thus, we need appropriate public sector mechanisms and points of contact to provide ongoing tailored support, across the lifecycle stages of any project.

- Community ownership is not for every community – the government should not push this as a blanket policy just for the sake of it. For those communities who are interested and where it is a viable solution, sufficient budget/resource should be provided for an equality impact assessment and collaborative engagement processes throughout, ensuring the process and the outcome are just.

- Community ownership OR private company ownership should not be a zero-sum game. More work on in-between models that might work more effectively for many places and would enable more diverse scaled projects would be welcomed. Sharing gain and responsibility between the people who now live with the infrastructure and

the changes (& risks) this brings, and the private company / local authority that carries more of the financial risk needs to be better understood and potentially promoted.

- "Community empowerment": more details would be welcomed on this as a draft outcome, as it appears vague and difficult to effectively measure. For example, would this include/ entail flexibility in grid connection regulations? A lot could fit into this category.

- "Local content and job creation" – this is welcomed but it is also important understand local content as beyond supply chain jobs and providing a community benefit fund. To start this off, it is important to increase participatory processes for decision making at the earliest stage possible. We would welcome government encouragement of project engagement with places *before* any plans have actually been set in stone. Other examples of local content include giving back to communities for their participation and maintaining local "content" as a local "relationship" with communities throughout the lifespan of energy projects (not just at consenting and then, 20 years later, at repowering stage).

- Interesting reference to hydrogen projects specifically in this section. EMEC PhD student considering just transition risks and opportunities of green hydrogen generation, for future info/ discussion (see Question 2 above).

- "Wider community benefit": clarity on what this means would be welcomed. Careful not to set a "money pot" goal that becomes the extent of community benefit as standard practice for everywhere.

- "Supporting regions and communities most at risk" - good initiative and very important. But in this strategy, "communities most at risk" is focused on those at risk from fossil fuel and adjacent industry closures, and this scope needs broadening urgently. What about "communities most at risk" from the mass deployment of renewable energy infrastructure? This will highlight different places on the map, (and sometimes there will be overlap with fossil fuel closure). Very important that Scottish Government proactively considers this to avoid locking in new injustices. This is one of many examples of risk layers/perspectives connected to the energy transition. Again, it is essential that government analyses move ***beyond*** *"most at risk from fossil fuel closures".*

- Also, in relation to "communities and places" theme overall: need to make sure that a "Just Transition" in one specific place is not provoking deep injustice elsewhere. Analysis of justice trade-offs is needed.

Theme 3 "People and equity":

- "Affordable energy to further equity" – we agree that there is a need to tackle the root of this problem. In places where mass deployment of renewables will happen, this is an essential point both for moral equity and justice, but also for social acceptance of the renewables transition. Some of the places where mass renewables deployment is predicted is also where some of the most extreme fuel poverty is, like in Orkney. The

government has an opportunity to bridge the technical and social gap when developing energy infrastructure policies and incentives. An example could be to consider the potential for renewables deployment to connect to addressing fuel poverty issues in particular places, instead of considering the renewables deployment piece as "technical" and energy affordability to relate only to the "social policy" or "subsidisation." It is also essentially important to ensure that new deployments are not making fuel poverty or other inequities worse.

- "Fair distribution of costs": yes, absolutely essential that costs are not "disproportionately borne by vulnerable". However, like with a lack of consideration of "reducing energy use", there is an elephant in the room about "those with more ability to pay to pay more". This is an important nuance to consider when redesigning energy policy and distributing costs. It connects to energy overconsumption and energy waste more generally. Also, in this context, it appears "distribution of costs" is thinking only of monetary costs. This is important, but it is not the only costs that will come from the energy transition. Other costs need to be considered – and these should *also* not burden the least powerful/ most vulnerable.

Theme 4 "adaptation, biodiversity and environment"

- Good that there is specific environment and just transition goals. However, would be even better to see nature treated as a core stakeholder, and considerations of what doing "justice by the environment" means being detailed in the text. Embedding this in the plan would likely change the look of certain actions / priorities when undertaking the transition, or at least the approach to them.

- Adaptation and resilience: should also include particular reference to, and support of those most vulnerable to climate impacts (climate justice). There is mention of this for power outages, but the just transition is essential for other aspects e.g., storminess or heat stroke too.

- "Environmental protection and restoration": great to see this in here as part of just transition. However, need greater clarity on how this will be undertaken. Point talks first about restoration and then focuses on "carefully managing and avoiding negative impacts in Scotland and overseas". Yes, but need more detail and need practical action on this. Currently the industry is very much focused on "mitigation", not *avoidance* nor the precautionary principle; and building in positive impacts or restoration/regeneration is still very much a last thought. Need more detail and metrics on this proactive approach to environmental restoration and harm avoidance. A possible example includes marine areas regeneration as part of biodiversity plans (like in NP4) for lease owners or changing language and requirements in consenting process (Marine Scotland) amongst others[28]. Some energy infrastructure could support environmental wellbeing and there is scope to study and implement this – even if solution is monetarily more costly.

[28] In England, approach for net gain to biodiversity in planning requirements: https://www.local.gov.uk/pas/topics/environment/biodiversity-net-gain-local-authorities

- The inclusion of “overseas impacts” is a welcomed mention as it is key that Scotland should not offshore environmental impacts. Ultimately, this is because then the global outcome (mitigation of climate emergency and injustice) will remain the same. However, we need real detail on this as at the moment inhe whole strategy this is very fuzzy and only words but no tangible regulations or actions or demands on energy projects have been stated. Developers need guidelines, legislated requirements, as well as transnational support to increase supply chain transparency and human rights standards, for instance.

- “Natural capital” – careful with only referring to nature in monetary economic system terms.

- A final, general point on JT outcomes: We need greater consideration on the potential for just transition trade-offs and multi-scalar impacts, over time and space. A just transition for Scotland should not come at the expense of injustice elsewhere, and this is injustice to nature and injustice to humans elsewhere, or future generations. There is an “avoiding risk on most vulnerable” here as well: there are places around the world most vulnerable to climate impacts, and most burdened historically by environmental issues and energy extraction. These places should not be further burdened by Scotland’s just energy transition. And Scotland genuinely leading the way worldwide with ambitious just energy transition policy could work towards improving outcomes for places that will be touched by Scotland’s energy transition (e.g. demanding human rights and environmental standards across lifecycle and supply chain of wind turbines that deploy in Scotland) etc. There is brief mention of “overseas” impacts in relation to nature which is a good start, but this brief mention requires detailed actions alongside it.

- Alongside this, it is also important to understand that justice will likely be about balancing trade-offs. It is likely that we will all need to make certain sacrifices, undertake changes and reach compromises. Within this, acknowledgement in this strategy of the most vulnerable not bearing the costs and risks is a welcomed start. Research undertaken in the just transitions and energy justice academic spaces, which highlight nuances across different forms of justice (distributional justice, procedural justice, recognition justice and restorative justice, amongst others) can provide valuable insight into these trade-offs and support in the design of whole-systems policies for the energy transition through a holistic lens.