

## Locational Marginal Pricing (LMP)

What does LMP mean for the north of Scotland?

Webinar Stakeholder Report: October 2022

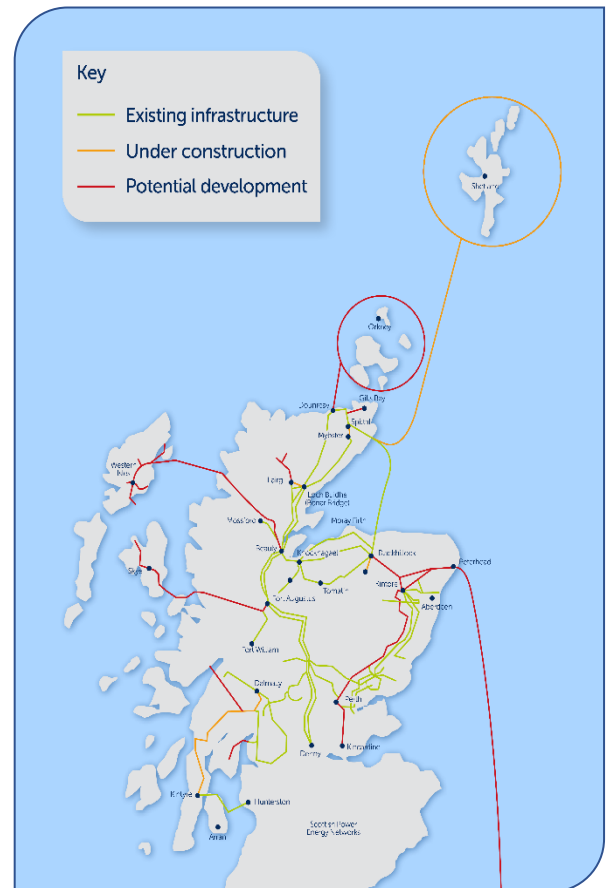
## About Us

We are SSEN Transmission, part of the SSE Group, responsible for the electricity transmission network in the north of Scotland.

As the Transmission Owner (TO), we maintain and invest in the high voltage 132kV, 220kV, 275kV and 400kV electricity transmission network in the north of Scotland and the Scottish Islands. Our focus is to deliver a network for Net Zero, facilitating Scotland and the UK's transition to a green, low carbon economy. Our network consists of underground and subsea cables, overhead lines on wooden poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass and crossing some of its most challenging terrain. We power our communities by providing a safe and reliable supply of electricity. We do this by taking the electricity from generators and transporting it at high voltages over long distances through our transmission network for onwards distribution to homes and businesses in villages, towns, and cities.

Scotland's transmission network has a strategic role to play in supporting delivery of the UK's Net Zero target. We're already a mass exporter of renewable energy, with around two thirds of power generated in our networks area exported south. By 2050, the north of Scotland will need 33-35GW of renewable energy capacity to support Net Zero delivery. For context, we currently have just over 8GW of renewable generation connected in the north of Scotland.

Find out more: [www.ssen-transmission.co.uk](http://www.ssen-transmission.co.uk)



## Introduction

Earlier this year, National Grid Electricity System Operator (NGESO) concluded their Net Zero Market Reform project, with the final recommendation being that GB should introduce Locational Marginal Pricing (LMP) / nodal pricing. Following this, Ofgem have initiated work on the first model showing LMP in a GB context, and the Department for Business, Energy & Industrial Strategy (BEIS) are considering the implementation of LMP through their Review of Electricity Market Arrangements (REMA).

As a stakeholder-led business, we have sought to understand the implications of policy and market reform that has the potential to impact us and our north of Scotland stakeholders. We feel this is particularly important, given that the north of Scotland is home to some of the UK's greatest renewable resources although it is home to 2% of the UK's population. The actions taken in the north of Scotland, to secure a greener and cleaner society, will contribute towards 10% of the total action required to reach Net Zero targets. Scotland's transmission networks play a critical role in this.

Our analysis has been underpinned by an assessment framework which we applied to international jurisdictions that have fully functioning nodal electricity markets such as New Zealand and Texas. The framework consisted of five assessment pillars: network planning & investment, generation mix, security of supply, market liquidity, and establishment period. From the analysis results we have begun to understand what the potential impact of LMP could be on the north of Scotland.

We have also been working hard to understand the core drivers that have led to market reform, such as LMP, being introduced. Literature and industry engagement has shown us that constraint management and the associated redispatch process via the Balancing Mechanism (BM), as a result of inadequate levels of transmission capacity, has been a large driver. This is an area that we are interested in and we will continue to work with our stakeholders on how to unlock the potential of the north of Scotland to enable the most efficient transition to Net Zero.

Our webinar presenting the above-mentioned analysis results allowed us to better understand our stakeholders' views on the topic as discussion surrounding potential market design changes within the industry continues. The vital feedback we received following the webinar has formed a key component of our REMA consultation response.

## Our approach

- We have engaged with NGESO, Ofgem and BEIS to understand how and when possible, market reform, such as LMP might be introduced.
- As a stakeholder-led business, we have sought to understand the potential implications of LMP to us and our north of Scotland stakeholders.
- We completed analysis which assessed the success of LMP in international jurisdictions that have fully functioning nodal electricity markets such as New Zealand and Texas.
- Our webinar presented this analysis to stakeholders, and we sought to gain our stakeholders views on what they thought LMP might mean for their business and the delivery of Net Zero.
- We used the feedback gathered during the event to help inform our response to Ofgem’s REMA consultation.
- Finally, we made our analysis available for stakeholders to consider when submitting their consultation responses.

The screenshot shows a webinar presentation with three slides. The first slide, 'Why are we assessing LMP?', features a pyramid diagram with 'ENERGY SECURITY' at the top (58/100), 'ENVIRONMENTAL SUSTAINABILITY' at the bottom left (66/100), and 'ENERGY EQUITY' at the bottom right (79/100). It lists industry activity from nationalgridESO, Ofgem, and BEIS, and outlines the company's approach: gain understanding through international examples, engage with stakeholders, and perform a principle-based impact assessment. The second slide, 'What is Locational Marginal Pricing (LMP)?', defines LMP characteristics (Centralised, Central Dispatch, Hedging mechanisms, Unknown subsidy) and explains the nodal market concept. The third slide, 'Three Node Constrained Circuit Design – North of Scotland Example', shows a diagram with nodes A, B, and C, and provides detailed data on generation mix, demand, and costs.

## Stakeholder Participation

Invitations were sent to a wide range of stakeholders on our SSEN Transmission distribution list. The webinar was advertised on our social media channels, with the event hosted on Microsoft Teams.

Stakeholders represented at the webinar can be seen in figure 1.

We received a positive response to the webinar:

- 164 people registered their interest in the event
- 100 people attended

SLIDO was used to capture participants views with:

- 76 people engaged with SLIDO

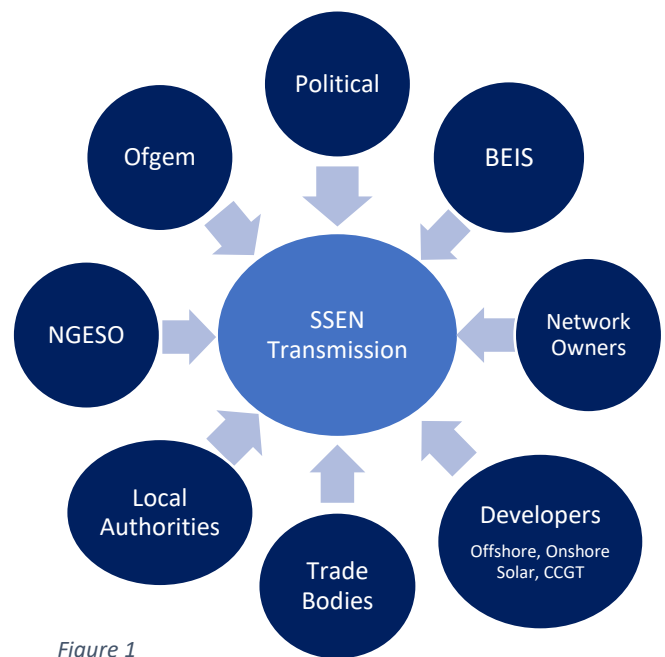
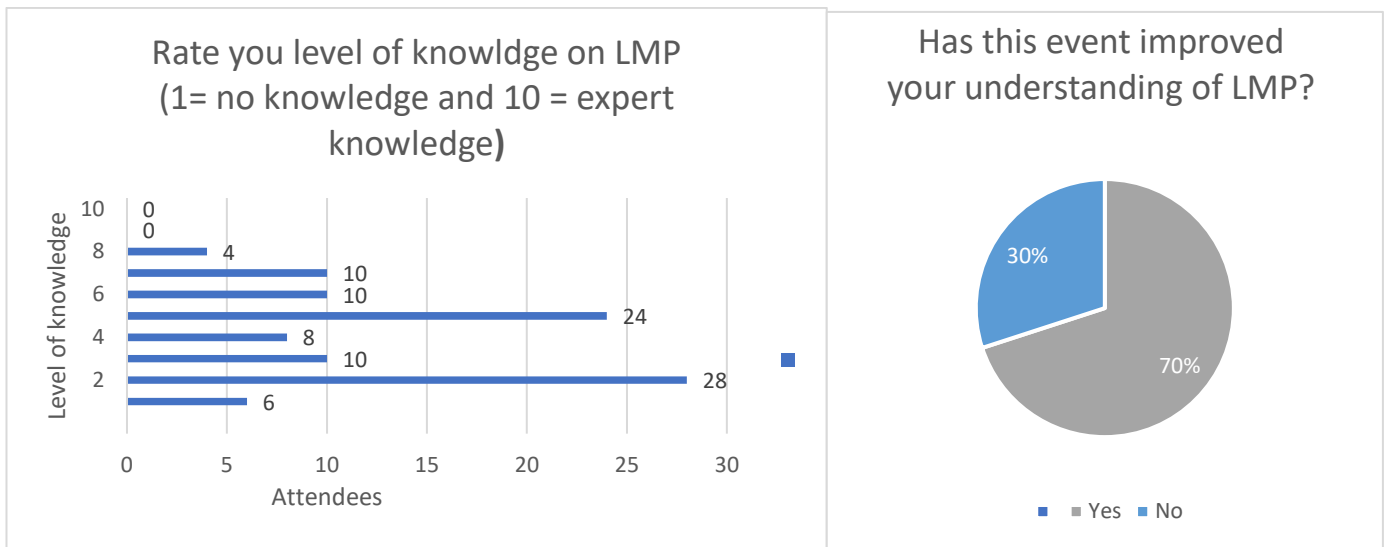


Figure 1

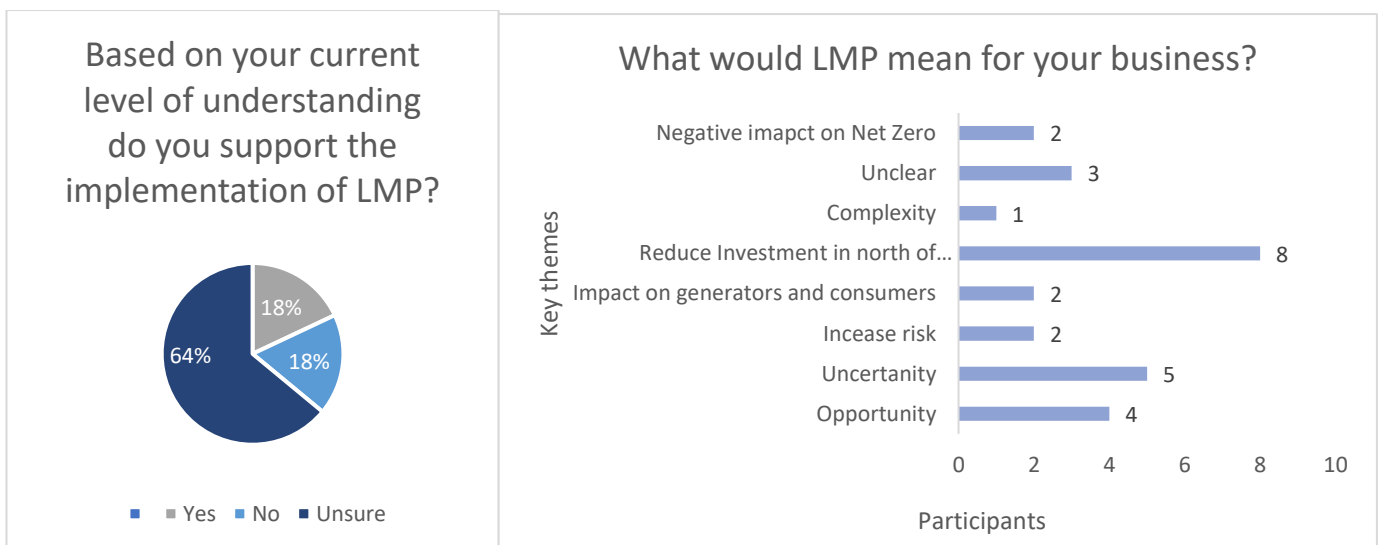
## Your feedback

Throughout the webinar we had fantastic engagement with stakeholders through the use of SLIDO. We used this to capture participants views through both open text options and polls. The following tables summarise some of the feedback received during the event.

We asked stakeholders to rate their level of knowledge on LMP at the beginning of the webinar then, at the end of the event we then sought to understand if the webinar had improved their level of knowledge. Of those who responded, the majority rated their knowledge as 4 out of 10, with 1 being no knowledge and 10 being expert knowledge. 70% said the webinar had increased their understanding of LMP.



We also sought to understand if our stakeholders were generally supportive of the introduction of LMP. 64% of respondents indicated that they were unsure, demonstrating there is a clear need for further discussion and analysis on LMP to help our stakeholders understand more fully the potential impacts of this policy reform. 27 participants provided a view on how LMP might impact their business, these comments could be split into 8 key themes which are shown below.



## Next steps

We have responded to BEIS' REMA consultation and will continue to engage with BEIS throughout this process, advocating for the interests of our stakeholders and customers throughout the north of Scotland.

As we progress our stakeholder led approach to deliver a [Network for Net Zero](#), our work on industry reform including charging, markets and access will continue. We plan to hold more events on a variety of different topics in the near future to continue this engagement.



## How to get in touch

We would love to hear from you to get your views on Locational Marginal Pricing (LMP) or other areas of the electricity market.

If you have any questions about this webinar, please get in touch.



**David Boyland** - Senior Commercial Policy Manager: [David.Boyland@sse.com](mailto:David.Boyland@sse.com)



**Nicholas Phillips** - Senior Commercial Policy Analyst: [nicholas.phillips@sse.com](mailto:nicholas.phillips@sse.com)

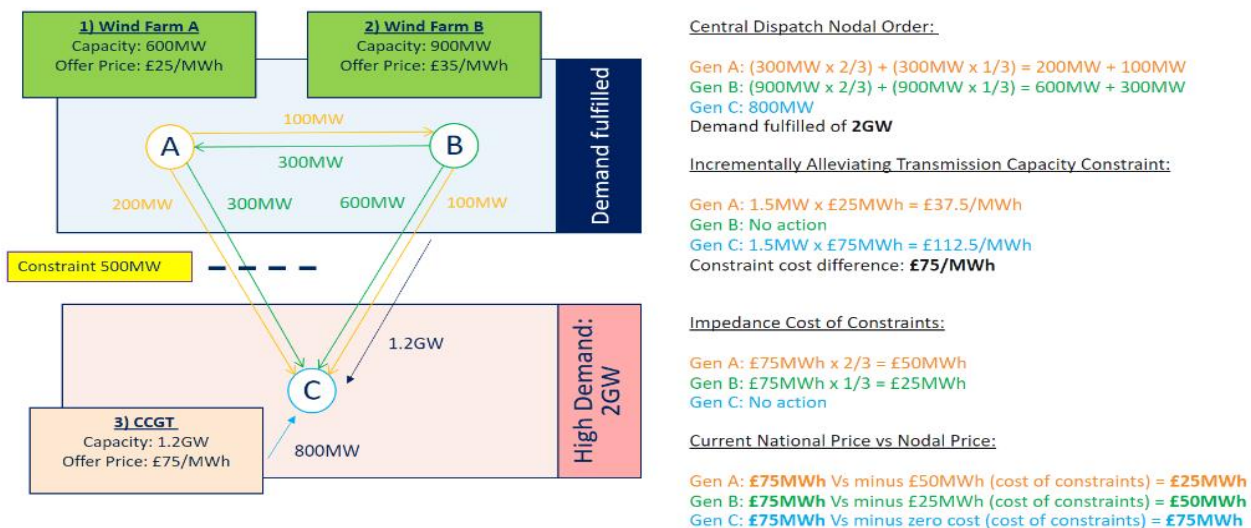
## Appendix 1

### Three Node Constrained Circuit Diagram – North of Scotland Example

At the beginning of the session, we presented an illustrative three node model to help explain some of the economic theory underpinning locational marginal pricing. The objective of talking through the diagram was to show how prices would differ for north of Scotland generators under a nodal pricing system, compared to how prices are set under status quo market arrangements. As noted during the presentation, this type of diagram is commonly used within academia and industry in order to show a form of real-life example that visually highlights different nodal prices. For more examples of how this type of diagram works, please refer to page 15 of National Grid ESO and FTI Consultants recent [Operation market design: Dispatch and Location Industry Workshop](#).

As also acknowledged during the webinar, there are several caveats to consider when analysing the below diagram. We appreciate that a lot of the information is illustrative and not accurately representative of what would happen in a real-life central dispatch nodal system. The figures relating to available generation capacity, offer prices of generators, demand assumptions, and the level of transmission constraints have all also been simplified, and are fictional in order to make the example as accessible as possible in what is a complex topic. The diagram also does not consider advanced parts of wholesale market mechanisms that would be involved in real life, such as transmission losses or nodal hedging mechanisms such as Financial Transmission Rights (FTR's) and their impact. With the above acknowledgements in mind, we hope that your understanding of the underlying concepts of locational marginal pricing are clearer following the session, and the potential impact on north of Scotland wholesale prices has become easier for our north of Scotland stakeholders to understand.

### Three Node Constrained Circuit Design – North of Scotland Example



Questions were raised in the session surrounding the order of dispatch used to meet demand. Participants asked during the session: *Why was Generator B was dispatched first, as opposed to Generator A, given that A has a lower offer price of £25/MWh compared to £35/MWh at B?* The answer to this is based on the impact of the transmission constraint and what this means for minimising the amount of dispatch required from Generator C, the generator that has the highest offer price of £75/MWh.

The below table breakdown highlights the cost difference between the two approaches, showing how it was optimal for system cost to dispatch a slightly more expensive generator first as a result of constraints on the network. If Generator A, the cheapest, is dispatched first at full capacity of 600MW, then this means that there is only capacity for 100MW of indirect flow from Generator B, which would dispatch at 300MW to fulfil this. As a result, this would mean in total there is 900MW moving to meet demand from the two north of Scotland generators, and that 1.1GW would be required from the most expensive generator at £75/MWh to meet 2GW of demand. Overall, this order of dispatch means that the cost to balance the network is more expensive given the large use of CCGT to fulfil demand. In contrast and as shown during the session, dispatching Generator B first and then Generator A overall means that only 800MW of CCGT at Generator C is required to meet demand, and therefore that cost to the system is decreased in comparison.

Dispatch Generator A 1st – Capacity 600MW @ £25/MWh: Total cost £108,000

Dispatch Scenario	Direct Dispatch (MW)	Indirect Dispatch (MW)	Price (£/MWh)	Cost (£)
Gen A	400	200	25	£15,000
Gen B	200	100	35	£10,500
Gen C	1,100	0	75	£82,500

Dispatch Generator B 1st – Capacity 900MW @ £35/MWh: Total cost £99,000

Dispatch Scenario	Direct Dispatch (MW)	Indirect Dispatch (MW)	Price (£/MWh)	Cost (£)
Gen A	200	100	25	£7,500
Gen B	600	300	35	£31,500
Gen C	800	0	75	£60,000

## Appendix 2

### Questions Answered Live

**Question 1 – The key element we should be considering is whether LMP will help us get to Net Zero, what is the main feature from LMP that will help us get to Net Zero, and it's not price.**

**Answer: Andrew Urquhart** - We support that comment. That's why as part of next steps in our assessment, will be to look at the principle-based system and whether it will help or hinder us to get to Net Zero.

**Question 2 - The second question will LMP reduce electricity prices to consumers in big renewable generation areas like the Highlands of Scotland?**

**Answer: David Boyland** – Throughout the presentation we purposely never spoke about consumers. The reason for this, is that we need to fully understand the implications on consumers. What we are seeing currently is messaging saying that LMP would reduce costs significantly in the north of Scotland (wholesale prices) and this is true to a certain extent. But we need to understand the other implications on other costs that may result from subsidising the renewable investment that is required to meet Net Zero, as well as the increased cost to equate for risk. So, although you may see a low wholesale price, it may be counteracted and diluted by other charges. This our current view however, we have not fully assessed this. We would advocate that Ofgem, and other decision makers undertake a full robust assessment as to what it means for consumers from start to finish, not just what LMP means to wholesale prices.

**Question 3 - Is there's no evidence that LMP increases decarbonisation and there is clear evidence that could actually hinder transition to Net Zero. Why is it on the table?**

**Answer: Andrew Urquhart** - Yes, that is why we are doing this particular assessment, because we feel that there's been a certain amount of industry reform that perhaps has theoretically identified what the solution might be. What we are trying to do is shine a light on the practicalities of it. Ultimately TNUoS in theory worked, but when you shine a light on the practicalities of it, there were challenges. So that is absolutely what we're looking to explore.

**Question 4 - Is there not a higher risk of stranded assets through anticipatory investment under LMP due to long lead times for construction?**

**Answer: Andrew Urquhart** - It is the sheer volume that is not only needed to hit our legislative targets in terms of offshore wind, 50GW by 2030 and so on. As well as all the solar, onshore wind and other targets we've got. Not to mention what we're doing with hydrogen. All of that is going to require the transfer of a lot of electricity from generation through to source, with certain elements of flexibility. That energy needs to get from where it's made to where it's needed. We would argue that there is a small risk of that leading to stranded assets.

**David Boyland** - To add to that, with anticipatory investment, it is key to note that this investment is not anticipatory when we can clearly define the need for it. So, it's not so much anticipatory, it's more enabling investment for what's actually required.

**Question 5: What are the key investment opportunities & risks for a renewable generator in GB as a potential result of LMP?**

**Answer: Andrew Urquhart** - There are some opportunities when it comes to LMP, like opportunities to locate where there are high prices at any given moment in time, but those prices will be a factor of many things; local constraints, availability of the network, as well as planning i.e. to be able to get planning will affect where you can locate your system. There will also be potential for network to increase going forward, you might target high prices in a particular area however that price may change due to a number of different things. There are a number of opportunities for flexibility, to hedge your bets you could collocate your system with storage. Finally, there may be opportunities with new financial mechanism such as FTRs. So, there are some opportunities but there are some clear risks which we hope we have explained throughout the presentation.



## Appendix 3

### Questions Answered Post Event

#### Question 1: Where is the carbon intensity pricing in all this?

**Answer** - This is excellent point; we have instructed LCP to undertake some work for us that tells us the cost of carbon as a result of turning renewable generation off in Scotland and turning CCGT on in England. Given the makeup of LMP we do not foresee this being improved, in fact the contrary.

#### Question 2: Do you believe FTRs are (or can be made to be) suitable for renewables assets? Do Wind generators in e.g. Texas make use or is more often thermal plant?

**Answer** - Yes, FTRs are used by all technologies in other countries who have an LMP market. FTR's within the Texas market are also referred to as Congestion Revenue Rights (CRR) for those more interested in this area.

#### Question 3: How is LMP & different regional prices going to impact on Energy Performance Certificates. The SAP/RdSAP software use a national price?

**Answer** - This is a great question and one that has not been considered as part of any work on LMP that we have seen to date.

#### Question 4: What are the main advantages of Nodal market against moving to Zonal Market?

**Answer** - We don't see many advantages in the context of Net Zero and the volume of renewable clean generation capacity that is required from the north of Scotland. That said, it could be seen that a nodal market would provide the right incentives at a demand side and for flexibility.

#### Question 5: LMP encourages the build out of transmission. But could also discourage renewable build out by lowering the nodal price near generating centres.

**Answer** - Yes, our view is that the transmission build out signals are already available without the need for radical reform to LMP. It is also key to note that the transmission build in the north of Scotland is also based on the capacity of generation connecting to it, any uncertainty for generation ultimately results in uncertainty in network investment.

#### Question 6: Have you modelled the impact of the drop in renewables generation in the North of Scotland and what this would do to nodal pricing in this region and Net Zero.

**Answer** - No, we have yet to model this, our view is that in order for GB to reach the national legally binding Net Zero requirements is that large renewable generation is required from across GB, in particular the north of Scotland. Due to this we believe that central decision makers would have to step in to subsidise generation existing and future, to allow GB to reach these targets.

#### Question 7: Has there been any consultation with generators specifically? Why would developers invest in a far more volatile market?

**Answer** - Not that we are aware of. We have been advocating that investor confidence and stability is required to ensure the timely and affordable delivery of net zero.

#### Question 8: Don't we need improved granular data to manage our future electricity system? Regardless of LMP?

**Answer** - Yes, we believe that the importance of transparent data sharing practices has never been so apparent.

#### Question 9: Will LMP encourage more private wire arrangements to avoid grid variability? E.g. offshore wind to hydrogen plant

**Answer** - This is an interesting point and one that we foresee as being a commercial option for developments, that said further exploration is required in this area.

**Question 10: The market is operated today by a third party. Will moving to LMP mean that it would naturally become operated by ND-ESO as they have the full grid model data?**

**Answer** – Institutional governance frameworks have yet to be discussed or explored in full however, those who advocate the implementation of LMP assume that the ‘market monitoring body’ would be the ESO/FSO.

**Question 11: Could the CSNP consider market reforms such as LMP to reduce/prevent unnecessary investment, or are both going to chase the same solution separately?**

**Answer** – This is a valid point, and the introduction of radical reform such as LMP and its potential impact must be considered in all ongoing legislation currently live such as CSNP

**Question 12: How do you see the impact on driving the wider works investment in UK? Do you think it will slow down the pace for the network reinforcement requirement?**

**Answer** – LMP would introduce a new series of locational signals, and as such we anticipate that these signals would need to be incorporated into new cost benefit analysis processes.

**Question 13: What is the impact of LMP on price signals that impact on conversion of Peterhead from natural gas to green hydrogen fuelling?**

**Answer** – This is an interesting question; this is a concept we have not yet developed thinking on and therefore are not able to comment.

**Question 14: What would it mean for those communities across the north of Scotland that are not connected to the GB network?**

**Answer** – These arrangements are being discussed across industry in order to determine a fair and equitable way to pay for electricity network, provided by network licensees, that forms the GB electricity system. If you have a privately funded network, then these do not apply to you.

**Question 15: Is the REMA assumption that lower nodal or zonal wholesale price will directly translate to lower consumer prices at those nodes / zones?**

**Answer** – Yes, there is a case that with the introduction of nodal/ zonal markets, consumers in the generation rich areas would benefit. We would urge this is treated with caution and that policy makers, including the regulator, undertake a full impact assessment on the cost benefit to consumers. This should also include the increased cost of capital due to risk and also the price of subsidising generation required to meet security and legally binding decarbonisation targets.

**Question 16: Does LMP result in removal of TNUoS or does it remove the locational element of TNUoS in some way. Would Scottish gens still have very high TNUoS charges.**

**Answer** - This is still fully to be explored, our view is that the wider locational element of TNUoS would no longer be applicable. However, there still would be local circuit, local substation, and a residual/ adjustment factor of TNUoS. The benefit of north of Scotland generation no longer paying high locational charges through TNUoS would shift to the risk of low wholesale prices.

**Question 17: Please can you discuss the impact on consumers of nodal pricing?**

**Answer** - The extent to which nodal pricing is applied to consumers is still to be determined in the GB setting. For example, in international examples, the effect applied to consumers has been dampened through offering zonal tariffs. This is potentially one way in which the extreme signals sent to consumers would be managed. Renewable generation in the north of Scotland will have to be subsidised through other measures which will ultimately end up on consumers bills, this alongside increase cost of capital, will see the benefit of low wholesale costs diminish significantly.

**Question 18: Will it have an impact on the amount of asset investments required to enable the required connections and infrastructure for the proposed renewables projects?**

**Answer** - A large number of our load schemes are highly dependent on the generation capacity we have connecting to the grid, any uncertainty for generation development translates into network investment uncertainty.

**Question 19: How can LMP (i.e. price incentives to locate generation close to demand) be reconciled with a planning system that pushes renewables in the opposite direction?**

**Answer** - We agree, it is important to consider that land consent and planning policy in England is expected to change. It is still to be seen if this will deliver future onshore development down south. We would advocate that generation should be present all across GB and there should be no barriers anywhere.

**Question 20: What can be done to ensure LMP does not become an excuse for underinvestment in grid infrastructure?**

**Answer** - We have been thinking hard about what the impact of LMP would mean for grid infrastructure. Current infrastructure is assessed against a cost benefit analysis system that focuses on constraint management and the associated cost of this process. In a nodal pricing system, the future CBA process for managing transmission investment needs to be clear and transparent. In other countries who have LMP, there are strong open data sharing practices which allow market data to signal network investment. Furthermore, the same principles apply, that uncertainty for generation means uncertainty for networks.

**Question 21: Will the auxiliary grid services (flexibility and balancing) provided by onshore wind be properly recognised and remunerated under LMP?**

**Answer** – As the capacity of renewable intermittent increases, it is imperative that policy makers ensure that any market reform including the consideration of implementing LMP needs to account for the impact on the full suite of market arrangements such as flexibility, balancing and restoration services. It could be argued that the move to central dispatch that is required for LMP markets could enable more efficient dispatch of ancillary services. That said, we believe that there needs to be further thought put into this and it needs to be fully assessed.

**Question 22: How will the locational marginal pricing work on existing connection offers and plants?**

**Answer** - Details on this are still to be confirmed on the practical implementation of LMP in a GB context. More complex market arrangements such as CfD also must be discussed.

**Question 23: Why have we to pay more for our electricity in the Highlands, where we are now being expected to greatly increase the amount of electricity we make and export elsewhere, and to put up with the associated disturbance associated with this, than do other areas that use this exported electricity?**

**Answer** - The current market is based upon one national wholesale price, as discussed in the presentation. That said, one of the proposed benefits of LMP is that the north of Scotland will clear cheaper wholesale prices. This may incentivise (theoretically) the demand side, such benefits need to be fully assessed. We would call for policy makers to undertake a robust impact assessment on this.

**Question 24: Is there a connection between LMP and the White Paper (December 2021) on localised electricity markets?**

**Answer** - We believe that the white paper is dealing with a slightly separate issue. The move towards LMP has come following National Grid ESO formally recommending it as a result of their Net Zero Market Reform project in May 2022 this year.

**Question 25: I would welcome SSEN's views on the impact (if any) LMP may have on SSEN's activities. Whilst it is all theory at this stage in Great Britain, it would be good to understand if SSEN has reviewed impact on TOs internationally.**

**Answer** - Yes, we have carried extensive research on the transmission aspect of international markets that have LMP currently introduced. We have covered our key findings on network investment through the presentation.

**Question 26: Will LMP help reduce the cost of electricity in places like Shetland, which is set to become an exporter of green electricity to the national grid, and where the cost of heating a home is double the national average?**

**Answer** - See answers above, in relation to consumer and demand costs, it is dependent on the level to which the demand side (such as consumers) is exposed to full LMP signals, which as of yet, we have no clarity on.



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