Illuminating the future:
creating a zero carbon grid

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Contents

Introduction

The UK's energy infrastructure is at a critical moment as it looks to deliver low carbon energy that is affordable, secure, and sustainable. A comprehensive transformation of the country's energy infrastructure is essential to support increased renewable generation, energy distribution, transmission, storage and the integration of promising technologies such as green hydrogen, data centres, and microgrids.

We are pleased to bring you key insights from a number of leading voices in the renewable energy sector. These experts provide practical advice on modernisation, regulatory reforms, and strategies to integrate new technologies and support the transition from fossil fuels to renewable energy. We are grateful to all our interviewees for offering their expertise and thoughtful contributions.

The transition to net-zero offers opportunities to rethink how we generate, distribute, transmit and store energy. While there are challenges on the path to achieving a zero carbon grid by 2030, with the right direction our energy infrastructure has the potential to become one of the UK's greatest assets.

I hope you find this report insightful and informative.

Maria Connolly
Partner,
Head of Future Energy & Real Estate
t +44 (0)7909 967 322
e maria.connolly@tlt.com

> The transition to net-zero offers opportunities to rethink how we generate, distribute, transmit and store energy.

Chapter 1: The big picture

The UK is at a critical juncture in its pursuit of a sustainable energy future. The transition from fossil fuels to renewables requires a fundamental transformation of the entire energy system.

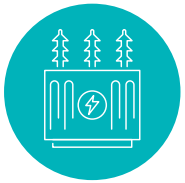
Grid will play a key role in this transformation. However, without urgent upgrades and strategic investment, the UK risks stalling its progress towards a low carbon economy, undermining public confidence in the energy transition, and its ability to meet its net-zero targets.

So how do we create a grid which is fit for the future?

Grid reform

"The grid was originally designed for large, centralised generators, but the transition to low carbon energy means it is no longer fit for purpose," says **Duncan Pomeroy, Director of Grid Connections at Enso Energy**. "It requires significant upgrades to support the shift to smaller generators dispersed across different locations."

On 1 October 2024 the ESO transitioned into the National Energy System Operator (NESO), assuming a broader role that includes overseeing electricity, gas systems and integrating new technologies. It's 'Beyond 2030' strategy advocates for significant infrastructure investments such as a £58 billion overhaul of the grid.



£58B

NESO's 'Beyond 2030' strategy advocates for a £58 billion overhaul of the grid

Recognising the challenges ahead, NESO and Ofgem are leading a series of reforms to modernise the grid and its regulatory framework.

Key among these are code changes known as TMO4+, which were due to come into force in January 2025, now postponed to Q2 2025. These will move the grid connections queue from a 'first-come, first-served' approach to 'first-ready, first-served', prioritising projects prepared for rapid deployment, as well as introducing strategic criteria to prioritise technologies in certain locations.

Alongside these reforms, significant upgrade programmes, such as the **Great Grid Upgrade, including projects like Eastern Green links 1, 2, 3 and 4**, will enhance grid capacity and resilience.

Government support

The role of the UK government in driving these reforms is critical. The Labour government has a renewed focus on energy security and an **ambitious goal of creating a zero carbon grid by 2030**. It also pledged to dismantle the backlog of 'zombie projects' waiting for a grid connection.

It is clear that to achieve this goal there will need to be a comprehensive reinforcement programme to provide significant new grid infrastructure and utilise existing infrastructure in more intelligent ways.

While the mechanism for implementing and funding these changes has yet to be confirmed, this shift has been met with cautious optimism.

"The government has set ambitious targets for a low carbon electricity grid by 2030. Is that realistic? Technically, yes. But two big things could still get in the way – people and the skills gap," says **Damon Rand, Managing Director and Head of Product at Cepro**.

Evolving grid dynamics

The upscale in renewable energy generation needed to achieve net-zero will drive the shift towards a decentralised and intermittent grid.

"Much of the transmission infrastructure that was built in the 1960s is reaching the end of its life. We need to build a significant new transmission infrastructure to connect renewable energy generation projects and replace the current life-expired systems," says **Damian Jackman, Technical/Commercial Lead at Field Energy**.

"The developed world has grid networks that are optimised for fossil fuel generators. The shift towards decentralised renewable generators, coupled with a change in industrial demand means that both generation and demand centres are shifting," says **Mark Wood, Managing Director UK at Ampyr Solar Europe**. "As a result, we have a legacy structure that is no longer fit for purpose."

National Grid Electricity Distribution expects there to be a fourfold increase in solar and onshore wind capacity and a tenfold increase in energy storage capacity. Upgrading the grid is pivotal to achieving those levels of deployment.

2030

The Labour government has a renewed focus on energy security and an ambitious goal of creating a zero carbon grid by 2030.

Damian Jackman says, "At the moment, the grid is the single biggest constraint in trying to grow the renewable capacity. Building new infrastructure is critical to enabling further deployment."

> The shift towards decentralised renewable generators, coupled with a change in industrial demand means that both generation and demand centres are shifting.

The impact of net-zero

When the challenge that the current grid poses to the rollout of renewables is combined with achieving net-zero targets the need for grid reform is ever more pressing.

"A lot of work has already gone into upgrading the grid. The next big challenge is doing so in a cost-effective way in line with net-zero targets," says **Andrew McAleavey, CFO at Luminous Energy**.

"The electricity grid exists for customers. We need to upgrade the grid to meet net-zero targets, and the focus needs to be on meeting customers' needs rather than just meeting generators wants," **McAleavey** adds.

Net-zero has also attracted interest and investment into the UK renewable energy sector. However, the need for upgraded grid infrastructure and supporting regulation has impacted this positive, creating barriers for developers and having the knock on effect of undermining investor confidence to some extent.

Without grid upgrades and intelligent grid management solutions the country's ambitious net-zero commitments are at risk.

Chapter 2: Current state of the grid

The UK is transitioning to a distributed generation model. This shift, as well as increased demand generally, has revealed the need for critical upgrades to the grid infrastructure which will address the capacity of the transmission and distribution networks.

Securing a connection

The UK's grid infrastructure is struggling to meet the demands of modern energy consumption and production. **Tony Gannon, Head of Downing Renewable Developments (a subsidiary of Downing LLP)** highlights this mismatch, stating: "Not only is the supply of grid connections insufficient for demand, but the way the grid network has historically been developed isn't fit for the embedded generation model that we have today."

These fundamental challenges have led to significant connection delays. **Gannon** explains: "Your connection is way in the future because the grid can't accommodate a connection in the short term. This is problematic because when you develop a project, you secure land, planning, and ancillary rights, which are generally time-bound. This leaves a gap, and without a clear project timeline, building a financing case becomes significantly more challenging."

> Your connection is way in the future because the grid can't accommodate a connection in the short term... This leaves a gap, and without a clear project timeline, building a financing case becomes significantly more challenging.

Spencer Thompson, CEO at Eclipse Power Networks, adds: "Securing a grid connection is currently the biggest challenge if you're trying to develop a project – it could be a solar farm, or a battery connection, or even a residential plot of 1,000 houses or EV hubs. Securing land and planning used to be the focus, but now the grid has become the big risk to developments."

Investor confidence and curtailment

Grid related issues including high curtailment rates and connection delays can also present a significant financial challenge – potentially impacting the viability and profitability of projects. **Enso Energy's Duncan Pomeroy** notes that these issues can have an effect on investor confidence. It is much harder to secure investment when you are asking people to invest in advancing a project where a firm connection date and point of connection has not been established.

In addition, high curtailment rates can reduce revenue streams and project viability and negatively impact on the overall efficiency of the grid and the environment benefits renewables projects can deliver.

Investor confidence, grid efficiency and the importance of renewables projects in achieving net-zero all highlight the need to create a grid which is fit for the future.

Long-stop dates & costs

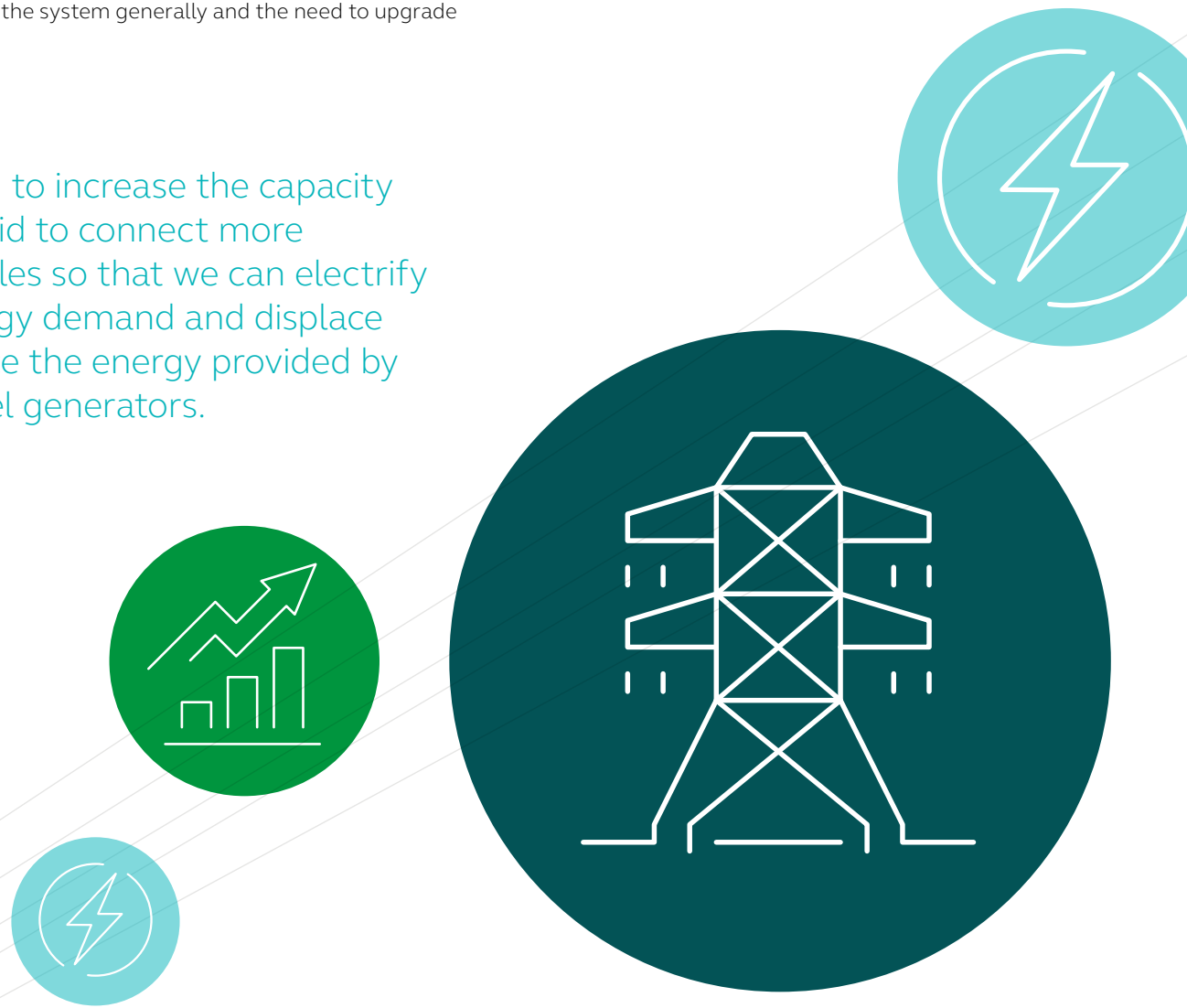
The lack of available grid capacity can delay individual projects and increase costs as developers have to cover the costs of grid reinforcements. While not limited to these areas, this problem is most acute in regions with high renewable energy potential where grid infrastructure is currently underdeveloped.

For example, the need for transmission reinforcement at every distribution level connection, routinely pushes projected connection dates into the mid-2030s, inflating the costs associated with building the necessary infrastructure, often making the projects completely unviable.

Nick Pincott, partner at TLT, adds that "at distribution level, a project will be required to pick up the tab for any reinforcement costs that it triggers, however small that project is. This is unlike transmission connections where charges are 'shallower', and the cost of wider reinforcements are shared by all users in their use of system charges. In practice, that means a generation project may be asked to pay for reinforcements that are at least in part down to greater use of the system generally and the need to upgrade outdated kit."

> We need to increase the capacity of the grid to connect more renewables so that we can electrify our energy demand and displace or replace the energy provided by fossil-fuel generators.

To address these challenges, a strategy focusing on short-term fixes and long-term strategic planning is essential. **Field Energy's Damian Jackman** emphasises the need for new grid infrastructure: "We need to increase the capacity of the grid to connect more renewables so that we can electrify our energy demand and displace or replace the energy provided by fossil-fuel generators."



Chapter 3: Addressing the key issues

Between October 2022 and April 2024, 275GW of generation capacity has been added to the transmission generation queue. NESO estimates in April 2024 put the total queue length at more than 800GW by the end of 2024, more than four times the total amount needed to achieve net-zero by 2050.

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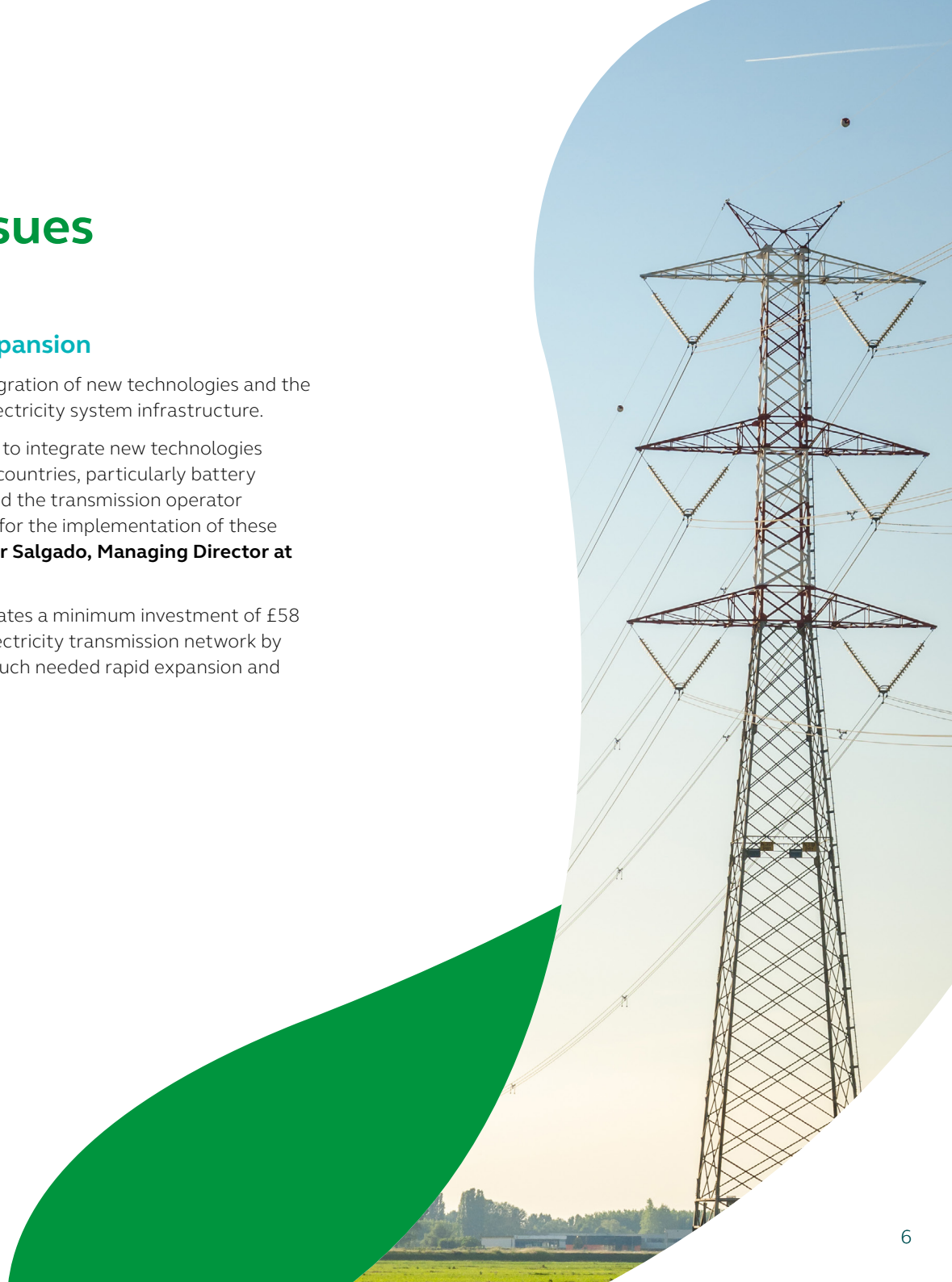
The new UK government has **committed to expanding renewable energy capacity** to 145GW by 2030 to achieve its zero carbon electricity goal. To bridge the gap between today's renewable generation and these 2030 targets, two key issues need to be addressed.

Technologies & expansion

The first – continued integration of new technologies and the rapid expansion of the electricity system infrastructure.

"The UK has been willing to integrate new technologies much sooner than other countries, particularly battery storage. The regulator and the transmission operator have tailored the market for the implementation of these projects," says **Luis Mayor Salgado, Managing Director at Enray Power**.

In addition, NESO anticipates a minimum investment of £58 billion in the country's electricity transmission network by 2030. This will support much needed rapid expansion and re-development.



Zombie projects

The second – zombie projects generated by the current queue management process. The growing backlog of projects awaiting grid connections, has meant that securing a spot near the front of the queue has become increasingly valuable. This, combined with the fees associated with withdrawing connection applications, means that there is a reluctance to relinquish a position in the queue, even if project viability is in question.

“Addressing the connections process and getting rid of zombie connections is key to achieving net-zero,” says **Luminous Energy’s Andrew McAleavey**.

A positive outlook

Amongst these challenges there is a positive which is key to achieving net-zero; a healthy pipeline of projects waiting to be connected to the grid. **Guy Nicholson, Head of Zero Carbon Grid Solutions at Statkraft** explains, “This means we have a hugely competitive industry which is attracting more developer and investor interest than it needs.”

“And as the industry starts operating on a first-ready, first-served basis, unviable projects will fall off,” he adds.

Chapter 4: Reinforcements & flexibility

To support the rollout of renewable energy generation that is needed to achieve net-zero targets, the grid needs reinforcement, and it needs to become flexible.

Reinforcements

TLT partner, Michael Kruger says: "In many parts of the country the grid is effectively full, meaning that if you want to develop a new project you are quite likely to trigger the need for grid reinforcement, whether that's at the local distribution level or at the transmission level."

This bottleneck in capacity can slow down the approval and connection process for new projects, adding significant delays and costs. In addition, the reactive nature of the UK's current grid system compounds these challenges.

Kruger adds, "The system traditionally waits for a project to be proposed before determining the need for reinforcements. The scale of the project be that 5MW or 500MW is not a determinate factor. This means that even small projects can trigger large-scale, expensive, and time-consuming grid reinforcements."

This unpredictability in cost and timing makes it difficult for developers to plan effectively and highlights the need for a more strategic, forward-thinking approach to grid planning that anticipates future capacity needs, rather than reacting to them on a project-by-project basis.

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As part of National Grid's Great Grid Upgrade programme, 17 major upgrade projects, including new high-voltage lines and undersea cables, are in development to increase the grid's capacity to transport clean energy to where it is needed.

Progress is being made. As part of National Grid's Great Grid Upgrade programme, 17 major upgrade projects, including new high-voltage lines and undersea cables, are in development to increase the grid's capacity to transport clean energy to where it is needed. The changes to the regulatory arrangements following The Electricity Networks Commissioner report, and the transmission acceleration action plan, have helped facilitate this.

However, this massive infrastructure overhaul is not without its challenges. **Downing's Gannon** acknowledges the critical nature of this effort but questions whether these reforms can deliver a zero carbon grid by 2030. He notes: "I don't think it is feasible unless grid upgrade works are significantly accelerated and resourced, particularly due to the scale of challenges that need to be addressed. It is not something the DNOs and TOs are equipped to do without further support."

And this is only one piece of the puzzle.

Flexibility

To match the variable nature of renewable energy, flexibility is an essential part of upgrading the energy infrastructure as **Enray Power's MD, Luis Mayor Salgado** explains: "There are two key elements needed to stabilise the grid: increasing flexibility to match supply and demand, and replacing the strength previously provided by thermal generation with new sources of inertia to guarantee stability."

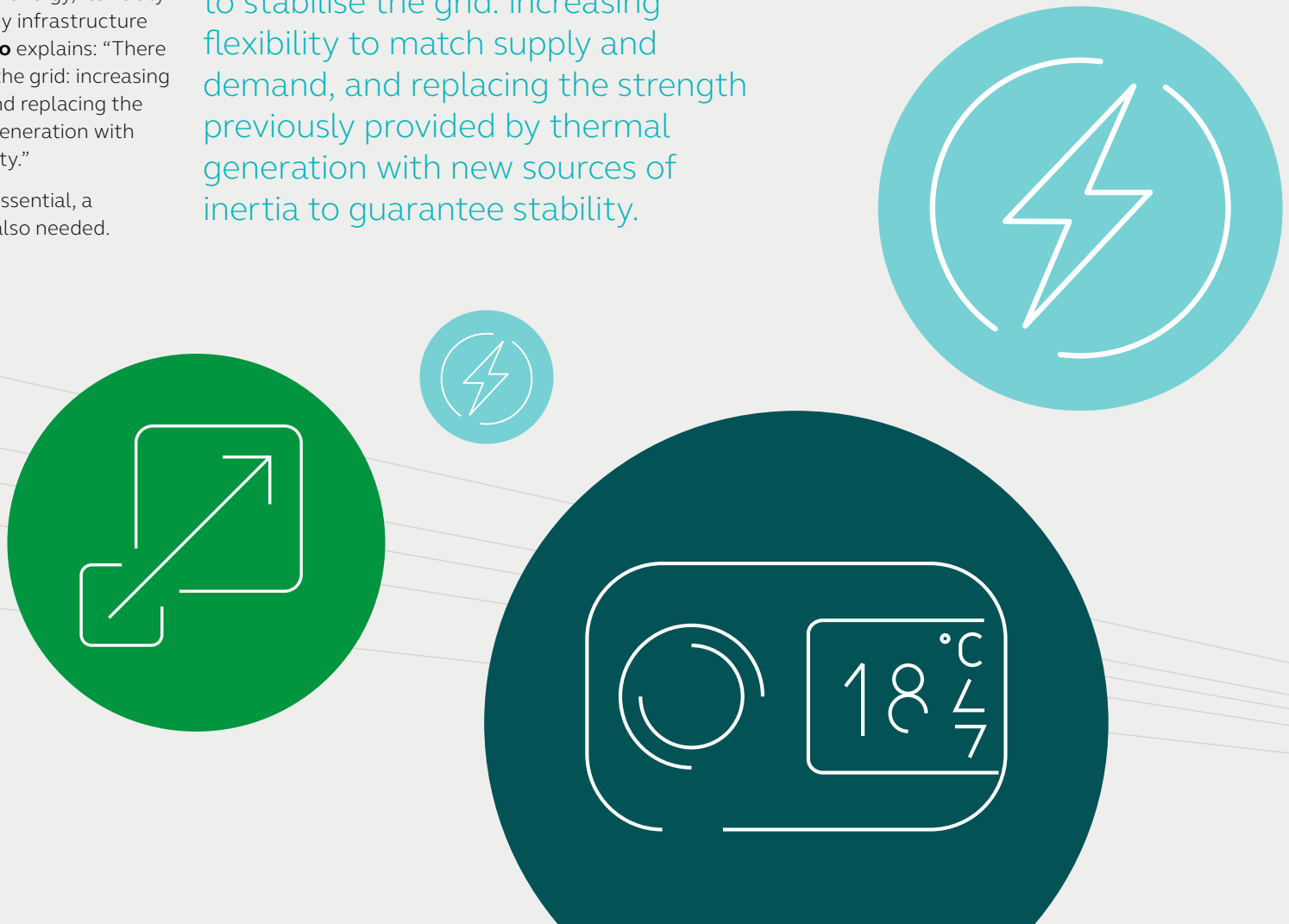
While developing short-term flexibility is essential, a broader and more long-term approach is also needed.

"We need to think about interseasonal flexibility," says **Gregory Triantafyllidis, Head of Project Engineering UK & Ireland at RWE**. "Different types of intermittent generation favour different times of the year. The industry needs to find a way to shift from intra-day peaks to managing peaks and troughs across seasons, with a solid view on the necessary energy mix."

"There are two key elements needed to stabilise the grid: increasing flexibility to match supply and demand, and replacing the strength previously provided by thermal generation with new sources of inertia to guarantee stability.

However, flexibility needs to go hand in hand with changing consumers' behaviour. "At the moment, there is no incentive for consumers to vary their behaviour at home. Most have fixed-term contracts that produce a fixed amount of KWh 24/7. From a consumer's perspective, it does not matter if that amount is used during the day or at night – this system does not make consumers energy conscious," **Triantafyllidis says**.

This means that all the benefits of renewable energy generation and grid improvements may not be fully realised without incentives to adjust consumer usage patterns.



Chapter 5: Regulatory environment and policy influence

REMA

One of the most significant regulatory undertakings in recent years is the Review of Electricity Market Arrangements (REMA). It represents a strategic overhaul aimed at aligning the UK's electricity market with the future demands of a decarbonised system, where renewable energy dominates. The REMA consultations are intended to create a more adaptable market framework that supports long-term investment in renewables and grid flexibility.

While the promise is clear, concerns have been raised about the potential delays in implementing these reforms. "Timing is crucial. There is a concern that the process could go on for years and not be delivered," says **Spencer Thompson of Eclipse Power Networks**.

Juliet Stradling, Partner at TLT, notes: "Some of the reforms that may come out of REMA, such as the introduction of locational pricing, would take a significant amount of time to implement, and so many of the investment decisions required to reach 2030 clean power targets would need to be taken under a transitional regime."

Investors will need to be confident that REMA will not undermine the business case for their projects.

TMO4+

The UK's regulatory environment has already allowed innovative grid management techniques to flourish as highlighted by **Cepro's Damon Rand**: "The UK is particularly a standout in terms of grid innovation, its regulation and regulators have allowed more innovation than other countries. What we've been able to do here over the past 20 years is only just being considered in many US states," he comments.

While Ofgem has played a pivotal role in these developments, further adaption of its regulatory approach is needed to address grid flexibility and provide more efficient connection processes.

A notable shift is the introduction of TMO4+ which aims to streamline the connections process by introducing a two-gate system that prioritises projects based on their readiness to connect. Gate 1 is an initial, indicative connection offer. Gate 2 is a confirmed connection offer for projects that have met specific readiness criteria and are prepared to proceed toward connection.

TMO4+

aims to streamline the connections process by introducing a two-gate system that prioritises projects based on their readiness to connect.

TMO4+ is also designed to remove speculative applications and "ghost projects" that are unlikely to go ahead, ensuring that only viable projects advance.

Ofgem has also sped up the reforms, spurred on by the new government's goal of achieving clean power by 2030 and the new Mission Control Unit overseeing this ambition, by aligning the grid connections process with strategic energy planning goals, such as the Clean Power 2030 Plan (CP2030), and the forthcoming Strategic Spatial Energy Plan (SSEP).

To this end, NESO has started to align the connections process with strategic planning, including more detail on Gate 2 to specify criteria for projects to enter and progress in the connections queue.

Lightsource BP's Robin Duncan expresses support, saying: "The change to the 'first ready, first connected' system gives us more confidence. We now know that when we are serious about building a project or bringing it forward, we can get it connected in a reasonable time frame."

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While this is a necessary step to clear non credible projects from the queue, **Enso Energy's Duncan Pomeroy** is concerned about the standing of ongoing projects that could get leapfrogged: "There is a concern that under TMO4+ potentially good, viable projects could become collateral damage because they are not able to tick all the boxes by the right date, or are no longer deemed to be the right technology in the right place.

The vision for a modernised grid is sound, but the practical hurdles of implementing such a large-scale upgrade, combined with connection reforms, could also present a risk. **Rob Smith, Regulation & Grid Development Manager at Enso Energy** explains: "TMO4+ amongst other things will require applicants to secure options on land parcels before submitting a connection application. Therefore, if the Gate 2 connection process doesn't offer you the location requested it is highly unlikely your project will proceed."

In September 2024, Ofgem published an open letter signalling further changes to the proposed TMO4+ regime. **TLT's Nick Pincott** says, "These changes will introduce new criteria relating to "strategic need" for the project, including the project technology type in that location."

In the near term this will add complexity for developers. "Long term, I think developers will welcome the certainty of knowing that their project is of a type that's needed in that location," says **Pincott**, "but in the meantime, they face a limbo period while CP2030 and the SSEP are are being prepared. With the publication of the SSEP delayed until the end of 2026, there is going to be an extended period where their detailed impact on the system remains unknown."

At the same time grid connections reform continues to evolve. In October 2024, NESO announced its proposal to require additional security for transmission connections. Its "financial instrument proposal" would require developers to provide appropriate financial commitment in the form of a "Capacity Commitment Fee" when they accept their Gate 2 offer under TMO4+. While this concept is not a new one, it was first mentioned in the **November 2023 Connections Action Plan**, the proposals and associated costs have raised some concerns from the industry. NESO plans to run a mini-consultation to enable industry participant to share their views.

Chapter 6: The role of battery storage

Battery storage

Battery storage plays a key role in grid balancing – providing reserve power when demand is high and absorbing excess power when it is low.

UK battery storage projects have reached almost **4.6GW/5.9GWh of capacity**, but projections estimate that **20-30GW** of energy storage is required by 2035. **Lightsource BP's Robin Duncan** comments: "We now have more intermittent sources of supply onto the grid. Balancing and storage are paramount in making sure the grid functions, and that we can accept all renewable generation from it."

20–30GW

20-30GW of energy storage is required by 2035

A significant scale-up is needed and while battery storage technology continues to evolve and investors are more comfortable with these projects, further changes to policy and more education is needed to support deployment.

"We are investing heavily in co-located batteries and developing standalone storage solutions. However, network operators still require further education to get really comfortable with battery projects," says **RWE's Triantafyllidis.** "In addition, the underlying policy is not there yet. We have overcome many policy hurdles with settlement authorities, which is a great accomplishment, but more needs to be done to educate network operators."

The role of battery storage will also continue to evolve explains **Enso Energy's Duncan Pomeroy**: "We know the grid is going to need more batteries and more storage. However, in the next 10-15 years, their role could change – we could be looking to utilise battery storage to provide other services (beyond just megawatts) to operate the system effectively, like stability or restoration."

Skip rates

Policy and education are not the only challenges. When it comes to adequately dispatching battery projects, skip rates also need to be considered.

“Skip rates continue to pose a big challenge to battery storage projects,” says **TLT’s Nick Pincott**. “There has been an increase in the number of battery projects that are lined up to provide grid services but are being negatively impacted by skip rates. While we are seeing some improvements, smarter solutions are needed to ensure that projects are better dispatched – only then will we see real change,” he adds.

> Skip rates continue to pose a big challenge to battery storage projects.

Statkraft’s Guy Nicholson agrees that this is a critical issue that needs addressing so battery storage projects can support the grid. “Batteries are going to play an increasingly important role, but skip rates are a significant hurdle. Currently, batteries are not used as effectively as they could be by NESO. A thorough change in the control room for system operation needs to happen, and this will take time.”

Dynamic line rating

However, the energy storage market is continually evolving, and solutions are emerging to ensure that batteries provide the most adequate service for a flexible and stable grid, such as dynamic line rating (DLR).

DLR technology increases the capacity of existing transmission lines by using real-world conditions, like weather forecasts and ambient conditions, to calculate the safe energy transmission limits for electrical conductors. DLR technology can be integrated with battery storage to help optimise power grids and enable new applications for utilities and service providers.

Enray Power has been looking into this, **MD Luis Mayor Salgado** explains: “DLR essentially tries to profile static line rating according to different conditions to adapt and carry more power. While it has not yet been deployed extensively, and is still quite rudimentary, this kind of key technology is going to be essential in unlocking flexibility and extracting more potential from the current grid.”

Co-location

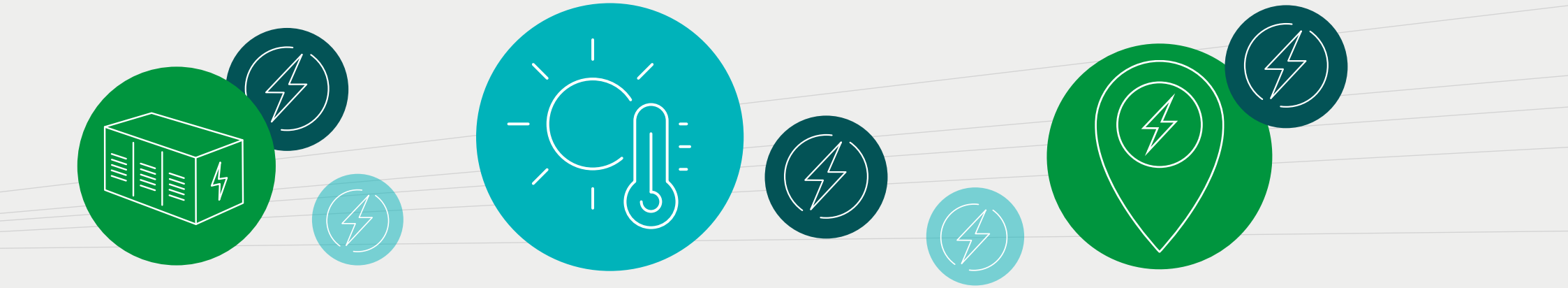
Within the battery storage landscape, co-location is recognised as being the most viable solution to support the rollout of solar onto the grid.

“We will continue to see a trend for co-located projects,” says **Field Energy’s Damian Jackman**. “However, it is worth noting that co-locating doesn’t always play out as expected. A large transmission-connected battery next to a substation, with a short connection, might be more flexible and cost efficient as a stand-alone project, rather than co-locating with a generator, like solar or wind.”

> We will continue to see a trend for co-located projects, however... co-locating doesn’t always play out as expected.

Enso Energy’s Rob Smith also touches on the challenges facing transmission-connected projects and highlights the key role that co-location can play. “Co-location for transmission-connected projects is quite important. It is all about optimising your connection, especially when the cost of building a 400kV connection is significant. Solar load factors mean a connection will not be fully utilised for many periods of the year.

“Adding a complimentary technology to share the connection, such as battery storage, increases the utilisation and lowers the per megawatt asset cost of the connection considerably with negligible impact on revenues of either asset.”



Chapter 7: Other balancing technologies

Green hydrogen

Green hydrogen could be a feasible option to balance the grid fluctuations expected from renewable energy. It can be generated from excess electricity, be used to generate electricity again, be transported from areas of supply to areas of demand, and used in fuel cells to meet peak demand, without the carbon dioxide emissions associated with fossil fuels.

10GW

The UK has set a target to have at least 10GW of green hydrogen production by 2030

The UK government had set a target to achieve **at least 5GW** of green hydrogen production capacity by 2030-2035. During the election, the new government **pledged** to double this to at least 10GW by 2030. Momentum has started to build. The government launched two tenders for the technology and in the Autumn Budget it was announced that funding will be provided to 11 new green hydrogen projects across England, Scotland and Wales. While this is a positive indicator of the commitment to green hydrogen as an essential part of the energy mix, there are still considerations around economic viability and policy roadblocks.

"Green hydrogen is one of the most promising technologies to help balance and stabilise the grid. It has great potential to store excess power and import it back into the grid when needed," says **Enray Power's Luis Mayor Salgado**. "However, the business case for hydrogen is not yet flexible enough," he adds.

As an early adopter of hydrogen in the UK, **RWE's Gregory Triantafyllidis** comments: "The government has acknowledged the need for a support scheme in the form of the Hydrogen Production Business Model. It is essential that decisions on the ongoing allocation round are taken quickly, and that future allocation rounds take place as previously committed to."

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Data centres

Data centres are an alternative and potentially innovative solution to help balance the grid. With uninterruptible power supplies and backup generators, they are well positioned to provide reserve power. They also have a role to play in balancing volatile generation and demand as they have batteries which can store energy and return it to the grid when the system is under strain.

"Data centres seem to be a big area of activity at the moment in terms of our involvement with Independent Distribution Network Operators acting as offtakers for private wire projects," says **TLT's Michael Kruger.**

> If we put data centres in places with excess generation, they can benefit from cheap electricity that could lead to significant system benefits.

One of the consistent challenges is the differing costs, demand, and supply across the UK grid networks. **Luminous Energy's Andrew McAleavey** believes data centres can help bridge that gap. "Areas with substantial generation could significantly benefit from this solution. If we put data centres in places with excess generation, they can benefit from cheap electricity that could lead to significant system benefits."

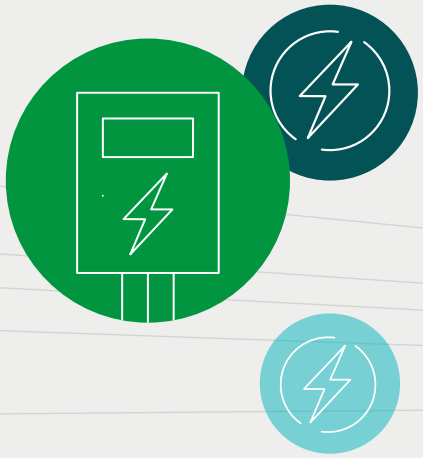
Microgrids

Microgrids have been attracting interest due to their resilient characteristics. As battery storage is a core feature of microgrids they can continue to function in adverse conditions, capitalising on renewables without any negative impact from intermittency.

Eclipse Power's Spencer Thompson says: "Microgrids are key to balancing supply and demand, enabling self-consumption behind the meter rather than always exporting to the grid. While customers traditionally export for revenue, reducing consumption from the grid with a microgrid can lower bills."

Microgrids can also provide electricity in remote locations and power areas without existing infrastructure: "A housing developer needed 20 MVA for 4,000 homes but was told it would take 6 years to connect. By deploying a private network with a microgrid, they reduced that to 5 MVA, cutting the wait to one year and significantly lowering connection costs," Thompson explains.

TLT's Michael Kruger agrees: "On the demand side, we are seeing a notable increase in microgrid-size developers engaging with residential house builders. These developers are offering to collaborate by installing rooftop solar panels and integrated battery systems. They also manage private networks, making it feasible to develop new housing projects in areas where the grid is constrained."



However, microgrids come with their own challenges. The planning and management needed to optimise the integration of various energy sources, load balancing, and grid stability can be complex explains **Kruger**: "This is a challenging model to execute, as the revenues depend on retail customers, and the retail supply market is notoriously difficult." **Kruger** continues, "There are several complexities in being a microgrid concessionaire for residential homeowners, but this approach could become increasingly important. It addresses both the housing crisis and the insufficiency of grid capacity. This feels like a major area for growth, if the challenges of making the business model viable can be successfully managed."

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In addition, scaling up a microgrid to accommodate increasing energy demand can be difficult and often requires significant and expensive modifications to existing infrastructure. This limits the broader adoption of microgrids in larger urban areas or regions with rapidly shifting energy needs. Government backing and support could be beneficial in overcoming these hurdles.

Chapter 8: Market dynamics

Unlocking investment

The private sector will continue to play a pivotal role in channelling investment into new renewable energy generation and battery storage projects; but again, the challenge comes with unlocking grid capacity and connectivity.

Eclipse Power's Spencer Thompson highlights the abundance of available funding for renewable energy but emphasises grid connectivity as a potential bottleneck for growth. "There is so much global private investment available; funding is definitely not the issue here. The challenge can be getting connected to the grid," he says.

> There's an appetite for much larger volumes of investment. If the grid can be unlocked, then that is going to encourage much greater magnitudes of investment into the UK.

Downing's Tony Gannon shares this opinion: "There's an appetite for much larger volumes of investment. If the grid can be unlocked, then that is going to encourage much greater magnitudes of investment into the UK."

Indeed, as **Thompson** points out, access to funding for renewable energy projects is not the route of the problem. So that the market can move forward at the pace needed to achieve a zero carbon grid by 2030, alongside significant grid upgrades there also needs to be clear routes to access funding to enable those projects. **Field Energy's Damian Jackman** agrees: "We need to increase the capacity of the grid to connect more renewables because we need to both electrify our demand and replace the energy provided by fossil fuel generators."

"Private players could potentially build grid upgrades faster and cheaper than the incumbent regulated business. And while a significant challenge remains around planning and obtaining consent, accessing private capital could help reduce prices and channel funds into these projects," **Jackman** says.

Industry buy-in

Alongside investment into grid infrastructure upgrades, wider support is need from the industry.

“Grid reinforcement projects are chasing some of the same supply chain components and personnel that our generation and battery clients are,” **TLT’s Nick Pincott** points out. “We need to tackle these challenges – a broader commitment strategy to stimulate investment from the industry is needed to achieve this.”

Encouraging this commitment and investment could be a question of scale as **Pincott** says: “There is an issue with scale. Recent initiatives have focused on large transmission network and grid upgrades. What is now needed are small tweaks to the system that would unlock, for instance, the potential for large quantities of batteries to be connected.”

> “Alongside investment into grid infrastructure upgrades, wider support is need from the industry.

And the building blocks could already be in place to achieve this. “There are former power station grid connections that developers are looking to redevelop with solar or battery. Unlocking those projects are almost the opposite of a great grid upgrade but could have a significant impact on unlocking potential where it is needed and enabling large-scale battery projects to be connected,” **Pincott** concludes.

Pincott also stresses the importance of the regulator moving at the pace needed to support private industry investment and support.

“The private sector is willing and trying to make progress, but there are occasions where they would like the regulatory wheels to move faster in relation to granting licences or exemptions,” he says.

Zero carbon grid

With the Government’s deadline for a zero carbon grid only 5 ½ years away, the industry is assessing its feasibility and asking if reassessment is due.

2030

With the Government’s deadline for a zero cabon grid only 5 ½ years away, the industry is assessing its feasibility and asking if reassessment is due.

“While there is a positive outlook with significant private and public sector investment to address not just the grid, but the associated challenges, the 2030 zero cabon grid target seems extremely challenging,” says **Enray Power’s Luis Mayor Salgado**. “Major network infrastructure projects typically take 5-8 years to deploy and that is with an accelerated timeframe. To be able to meet the 2030 deadline, there needs to be a very clear holistic view of what the energy mix is going to look like, and we need to start delivering on that today. Unfortunately, what is currently missing is that clarity,” he says.

From a geopolitical perspective, the credibility of net-zero targets is intertwined with maintaining the credibility of climate change altogether. A sustainable, stable, flexible, and modern grid has an important role in this.

> “Consumer confidence in the transition is one of the key factors.

Cepro’s Damon Rand explains: “Consumer confidence in the transition is one of the key factors. There is already political backlash on the idea of net-zero, and an excuse for not transitioning could be that the infrastructure is not up to it. This could be evidenced by things like electric vehicle charge points not working, or house builders insisting on the continued use of gas boilers because the grid’s not ready yet. The grid needs to be better in a way that is widely recognised outside of just the energy industry, rather than being painted poorly as an excuse for doing nothing.”

Could the solution be to redefine what is classified as a successful achievement a zero carbon grid by 2030? **Statkraft’s Guy Nicholson** believes so: “Becoming obsessed with achieving a zero carbon grid is not the right approach for the industry or wider public opinion. My estimate is that by 2030, we will have 95% of electricity coming from renewables and 5% coming from fossil fuels. And that is a great place to be.”

Expert recommendations

“It’s crucial to visualise what the grid will need to look like in the medium term and how we can synchronise consumption with demand and enhancing system flexibility. A great deal of work has been done to drive the necessary changes to create a decentralised grid. There is a clear vision of where we need to go; we understand the challenges, and we have the solutions. Now, it is about implementation – driving that change and realising the vision.
Luis Mayor Salgado, Managing Director, Enray Power

“Geographical diversification is important given the changes coming as part of REMA, and the unknown effects of locational marginal pricing. However, organisations also need to look to a more diverse set of skills in-house. Alongside the basics of securing land, grid and planning, teams now need to understand power markets and different macroeconomic factors.
Michael Kruger, Partner, TLT

“Projects have become more complex. Hybrid projects involve different routes to market, each with distinct deadlines and demands. Previously, it was straightforward: once the project was built, the offtaker would purchase the output at a discounted rate, referenced to a market index. However, today, it is essential to maintain a constant dialogue with grid operators and regularly demonstrate progress.
Nick Pincott, Partner, TLT

“We need more hybrid sites. Huge blocks of solar generation and massive onshore wind farms have a limited appeal in today’s objector-heavy environment. Greater hybridisation i.e. combing solar, wind, biomass, storage, whatever else may be feasible, and maximising the utilisation of each grid connection is essential. That is the more intelligent approach we need to take to development.
Robin Duncan, Development Manager, Lightsource BP

“Network operators and Ofgem should consider the advantages that flexible assets can offer and look to integrate them into the network. This would present a significant opportunity to introduce additional generation and coupled with efforts to set aside the Southampton projects and advance projects that are ready to launch, we can make significant progress towards the 2030 goals.
Tony Gannon, Head of Downing Renewable Developments (a subsidiary of Downing LLP)

To enhance the efficiency of our transition towards net-zero, it is crucial to address the bottlenecks and expedite the expansion of the transmission network. Other critical areas which need to be considered are planning challenges, constructing new overhead lines on the mainland and addressing how to compensate residents living near these infrastructures. These measures are part of the broader spectrum of solutions that need to be implemented to resolve and streamline our approach to infrastructure development.
Damian Jackman, Technical Commercial Lead, Field Energy

The issue of grid has become a focal point, and we have engaged with MPs regarding the importance of grid connectivity. The more we discuss it, the better. Grid connectivity is a substantial issue that we must address.
Spencer Thompson, CEO, Eclipse Power Networks

Grid reform has sometime felt like a Sisyphean task – the completion of each major reform is overshadowed by a seemingly ever-growing connections queue. But the achievements have been real and technical reforms, for example to the way in which batteries are modelled, have certainly led to more projects being connected than would otherwise have been the case. The challenge now is to ensure that TMO4+ is implemented in a manner that is flexible enough to allow evolution in the future but with appropriate governance.
Juliet Stradling, Partner, TLT

The UK market is, in many ways, several years ahead of other markets. The UK, while facing its own challenges, has made substantial progress in deploying renewables. There is strong demand for both developing and funding new projects. The grid has also evolved significantly to support the transition to net-zero. While work is still to be done, much has been achieved.
Andrew McAleavey, CFO, Luminous Energy

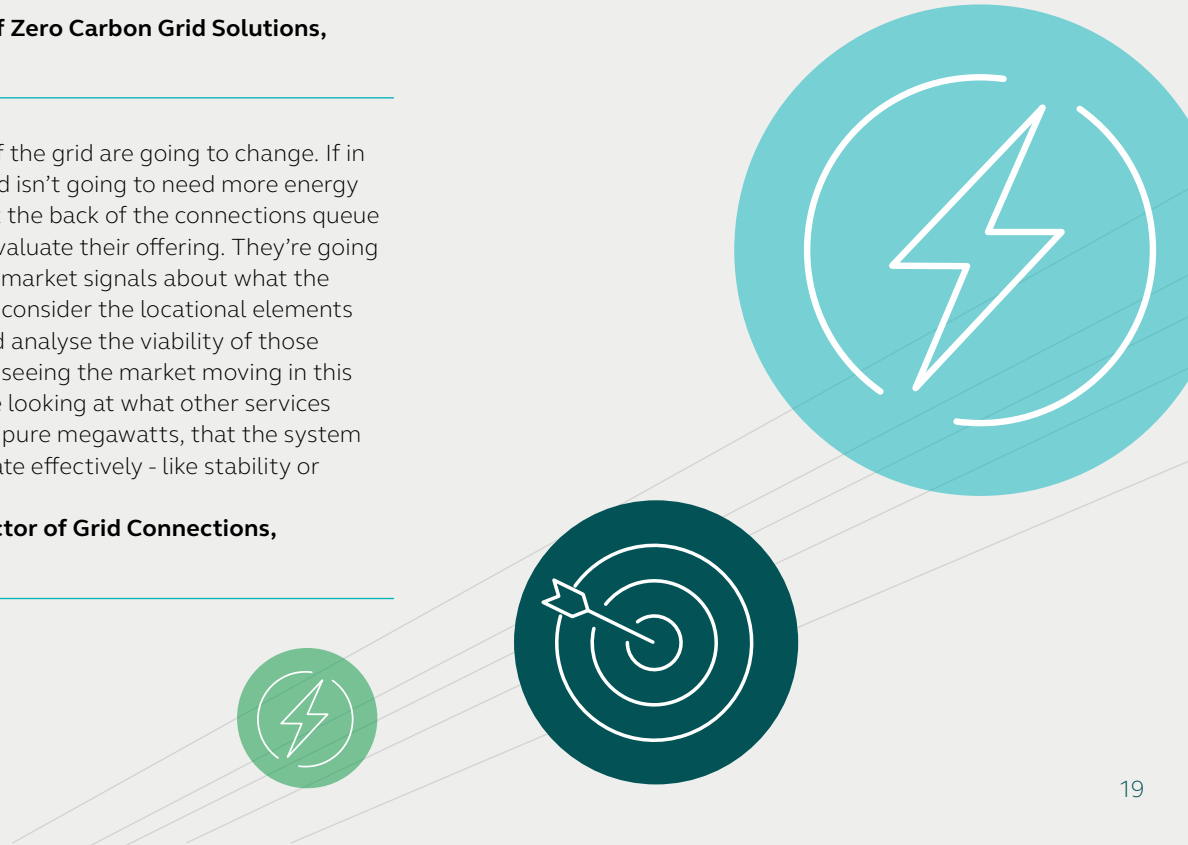
In terms of grid solutions, the focus should be on digitising everything faster and more comprehensively. Digital technologies, including the Internet of Things and metering systems, have advanced significantly. However, we are still operating on 2009-era smart metering standards, with very little progress made on enabling visibility into energy flows on the secondary distribution transformers that feed homes and businesses most directly.
Damon Rand, Managing Director and Head of Product, Cepro

We already have the technology: wind, solar, battery storage, and interconnectors. These are proven, cost-effective solutions. Let's focus on what we know works, and we'll solve the problem. If other technologies, like tidal energy or new forms of storage, come along, that's great, but for now, we have the solutions we need. It works. It's proven. Let's get on with rolling it out and not waste time with alternatives.
Guy Nicholson, Head of Zero Carbon Grid Solutions, Statkraft

The requirements of the grid are going to change. If in 10-15 years' time the grid isn't going to need more energy storage, then projects at the back of the connections queue are going to need to reevaluate their offering. They're going to need to look for early market signals about what the system is going to need, consider the locational elements of operating the grid and analyse the viability of those services. We are already seeing the market moving in this direction, developers are looking at what other services could they offer, beyond pure megawatts, that the system is going to need to operate effectively - like stability or restoration services.
Duncan Pomeroy, Director of Grid Connections, Enso Energy

There needs to be more focus on collaboration. The current approach tends to treat projects separately rather than as a cohesive whole, and with increasing pressure on the supply chain and new regulations on the horizon we could find better solutions with greater cooperation.
Gregory Triantafyllidis, Head of Project Engineering, RWE

I think this needs to be a collective solution. We're making progress, but the current dynamic nature of the industry requires a more holistic and centralised view of our needs and how to deliver them. We are starting to see that shift, but it requires input from all stakeholders to form a centralised approach that benefits us collectively.
Mark Wood, Managing Director UK, Ampyr Solar Europe



About TLT

TLT For what comes next
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We're your business advisers as well as your lawyers, working in step with you to protect your interests today and progress your ambitions for tomorrow.

With local, national, and international reach, we draw on our diverse expertise to find solutions and look ahead to create new opportunities.

We're a leading adviser to the global future energy sector. Immersed in the sector as it's grown, we've built an unrivalled track record delivering what our clients need so that they can lead the journey to net-zero and a more sustainable future.

We've also grown one of the UK's largest and most experienced financial services legal teams, with the expertise and solutions to deliver what you need.

We specialise in the future energy sector; digital; financial services; leisure, food and drink; real estate; retail and consumer goods; and public sectors, offering tailored, commercial advice rooted in experience.

Contacts

Maria Connolly
Partner, Head of Future Energy & Real Estate
t +44 (0)7909 967 322
e maria.connolly@tlt.com

Gary Roscoe
Partner, Banking & Finance
t +44 (0)7917 202 347
e gary.roscoe@tlt.com

Michael Kruger
Partner, Banking & Finance
t +44 (0)7823 467 114
e michael.kruger@tlt.com

Victoria Quek
Partner, Banking & Finance
t +44 (0)7815 651 572
e victoria.quek@tlt.com

Kay Hobbs
Partner, Corporate
t +44 (0)7880 094 727
e kay.hobbs@tlt.com

Antonia Silvestri
Partner, Corporate
t +44 (0)7798 652 635
e antonia.silvestri@tlt.com

Damien Bechelli
Partner, Corporate
t +44 (0)7507 643 208
e damien.bechelli@tlt.com

Juliet Stradling
Partner, Energy Regulation
t +44 (0)7866 893 388
e juliet.stradling@tlt.com

Katherine Evans
Partner, Head of Planning & Environment
t +44 (0)7799 621 022
e katherine.evans@tlt.com

Andrew Ryan
Partner, Planning & Environment
t +44 (0)7867 905 204
e andrew.ryan@tlt.com

Nick Pincott
Partner, Projects Infrastructure & Construction
t +44 (0)7970 388 552
e nick.pincott@tlt.com

Matthew Grimwood
Partner, Real Estate
t +44 (0)7880 173 945
e matthew.grimwood@tlt.com

David Miller
Partner, Real Estate
t +44 (0)7890 596 180
e david.miller@tlt.com

Nick Shenken
Partner, Real Estate
t +44 (0)7976 910 794
e nick.shenken@tlt.com

Kerri Ashworth
Partner, Real Estate
t +44 (0)7771 338 117
e kerri.ashworth@tlt.com

Joe Kelly
Partner, Real Estate
t +44 (0)7890 901 810
e joe.kelly@tlt.com

About inspiratia

inspiratia is a global thought-leader in the new energy and infrastructure sectors. They help clients to grow their business by informing them of project developments, financing innovations and new sources of capital, influencing the evolution of the industry, and inspiring leadership in the energy transition and infrastructure sector.

The qualitative analysis for this report was based on in-depth interviews with leading representatives from across the renewables industry, conducted over the summer of 2024. All information in this report is accurate at the time of publishing – November 2024.

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