

CHALLENGES AND
TENSIONS IN
ACHIEVING NET
ZERO 2050
WALES



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EXECUTIVE
SUMMARY

Executive Summary

Introduction

In Summer 2022, Mace Consult was commissioned to deliver a research project, for the National Infrastructure Commission of Wales (NICW), on maximising co-benefits and managing any tensions that arise from a 2050 renewable Wales.

The aim of this commission was to seek an understanding of the relationship between future renewable energy and associated infrastructure, and its impacts, which create both opportunities and tensions for the communities in which they are deployed.

Working with NICW and stakeholders, we have mapped tensions and challenges across a project timeline from Strategic Definition to 2050 and beyond with a specific focus on onshore projects. We have also identified areas of opportunity to address some of these tensions and challenges.

Our objectives were as follows:

- Recommend what policy and/or regulation should be considered to maximise the benefits from co-locating different infrastructure related to renewable energy deployment; and the opportunities from a large increase in deployment by 2050?
- Understand the relationship between future renewable energy and associated infrastructure and how this creates both opportunities and tensions for the communities in which they are deployed
- Build a comprehensive understanding of interdependencies and systems to deliver on scenario 2050 objectives
- Present a conclusion and recommendations by setting out the case for change

The project has focused on how the national ambition for a cleaner, greener Wales dovetails with delivery, answering the questions of what is enabling the delivery of Net Zero Wales 2050 from an infrastructure perspective and what is standing in its way. The purpose of the report is to provide a set of recommendations to be shared with Ministers, policy makers, energy developers and investors on how strategy, policy and practice can be improved to maximise benefits and address challenges and tensions.

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Themes from our findings

Early in the project it became apparent that the findings from the research and stakeholder engagement could be themed across the project lifecycle. Many of the opportunities and tensions were not specific to a geographical area or energy modality but related to a stage in the journey from project feasibility through to renewable energy being in use. With that in mind we have structured our report around the project lifecycle; going through all the stages of bringing successful green energy schemes into use. Before working through the project stages, it is important to understand the strategic context in which Welsh Government and industry is operating. During the commission, we were also requested by NICW to horizon scan past 2050 and provide ideas on what a longer-term future might look like.



Fig.1: Stages of the project

Section	Focus
Feasibility and deliverability	<ul style="list-style-type: none"> Translating ambition and strategy into delivery Attracting investment and development Understanding place Prioritising schemes Maintaining delivery confidence
Infrastructure	<ul style="list-style-type: none"> Site identification Grid capacity visibility Co-location of infrastructure
Planning	<ul style="list-style-type: none"> Planning system in Wales Planning Policy Framework Planning capacity and capability Guiding development Funding
Delivery	<ul style="list-style-type: none"> Grid capacity Supply chain Availability of workforce and skills Energy storage Infrastructure delivery
In use	<ul style="list-style-type: none"> Export agreements Skills maintenance Business continuity Public engagement Windfall tax
2050 and beyond	<ul style="list-style-type: none"> Energy infrastructure trends Consumer transformation trends Expanding existing infrastructure

Table 1: Report focus by section

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Each section of this report breaks down the context, tensions and challenges and a set of recommendations for each stage in the project lifecycle, culminating in a set of 20 recommendations for consideration by Welsh Government, local authorities, and other stakeholders.

Recommendations

During our interaction with NICW and the Project Advisory Group¹ we asked stakeholders to review and assist with refining these recommendations.

Stakeholders informed us that although they could clearly see the articulated vision for achieving Net Zero, there were a significant number of challenges and tensions in relation to renewable energy infrastructure that would need to be addressed to turn the vision into reality.

This report takes on board the feedback from stakeholders who shared their comments on the initial draft. Whilst we appreciate that work is on-going that has not been captured in this report, one of our primary recommendations is for all stakeholders to communicate their work very clearly to all those involved in renewable energy.

Further work will be undertaken by NICW to refine recommendations to Welsh Government and Ministers.

Acknowledgements

This report is the culmination of the work that has included multiple stakeholders from Welsh Government, local authorities, the energy sector, and young people in Wales. Mace would like to thank all those who took part for their generous contribution of time and insight.

¹ The Project Advisory Group is part of the Governance Framework for a set of three complementary research projects commissioned by NICW. It is made up of representatives from Welsh Government, Local Authorities, Energy Companies and Networks across Wales.

M E T H O D O L O G Y

Methodology

Mace has used our delivery approach of Analyse, Understand, Evaluate, Advise to present our conclusion by engaging with a range of stakeholders from both public and private sector to build a picture of the current landscape of renewable energy infrastructure and what this may look like on Wales's journey to Net Zero by 2050 and beyond.



Fig. 2: Methodology

Analyse

Data assessment

Mace conducted a current data assessment of Wales, looking at demographic profiling, geographical analysis to current energy use and the projected energy mix. We investigated the impact of existing and future renewable energy schemes on communities in Wales, looked at how these are being implemented and the challenges and tensions that arise.

At this stage we also reviewed the current trends and insights by analysing the current energy strategies and scenarios across Wales to understand the Welsh energy landscape. At the time of writing this report the full energy scenarios, commissioned as a separate work package, were not available to us and we have used the most up to date information we can from stakeholder feedback.

Stakeholder Identification

We identified key stakeholders to engage with that could help us build a more accurate and realistic picture of the issues that are currently being faced in Wales as well as potential issues that could arise in the future in the journey to Net Zero 2050.

Our key stakeholders included:

- Welsh Government Energy and Planning departments
- Project Advisory Group (PAG)
- RenewableUK Cymru Onshore Developers Group
- Local Authorities
- Energy companies / Developers
- Community Energy Organisations
- Youth organisations

Policy and planning review

We have undertaken a desktop review of existing policies and have used this to inform our stakeholder engagement sessions as well as identify any gaps and barriers created from this.

We have taken into consideration a range of documents and reports for this commission including (but not limited to) the regional energy strategies, Future Wales: The National Plan 2040 and the sixth carbon budget. A full list of our literature review and referenced documents can be found in the bibliography.

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Understand

Stakeholder Engagement

Following our initial data gathering and policy review, we conducted stakeholder workshops and interviews.

Group Engagement Workshops

Community Renewables Workshop

A workshop was held with representatives of community/local energy projects across Wales. The aim of engaging with this group of stakeholders was to look at tensions and barriers on a community level and to identify any barriers that they may have experienced with policy.

Mace's key research questions and objectives from the workshop were:

- Identify tensions and challenges that could arise from a 2050 renewable Wales and how these could be managed locally and nationally.
- Identify any perceived social, environmental, or economic barriers to delivering or supporting renewable energy infrastructure.

Future Generations Wales

Mace held a workshop with attendees and alumni from the Future Generations Leadership Academy. The academy was set up by Future Generations Wales to support and inspire the future leaders of Wales and to help achieve the aspirations of the Wellbeing of Future Generations Act. Six attendees volunteered their time to attend a workshop to explore the tensions and challenges that will arise from a 2050 renewables Wales from the perspective of young people. During the session we asked the attendees for their thoughts on tensions and challenges that may arise in general including thoughts on current regional strategies, existing or potential jobs and skills opportunities for young people in Wales, identification of barriers in gaining access to work in the renewable energy sector and ways to increase these opportunities.

Local Authorities Workshop

A similar approach to the Community Renewables workshops was taken to this workshop with representatives from local authorities across Wales in attendance.

Mace's key research questions and objectives from the workshop were:

- Identify tensions and challenges that could arise from a 2050 renewable Wales and how these could be managed locally and nationally.
- Identify any perceived social, environmental, or economic barriers to delivering or supporting renewable energy infrastructure.

All local authorities were invited to attend. Attendees included representatives from a range of roles such as planning and climate change officers from the following councils:

Blaenau Gwent County Borough Council
Bridgend County Borough Council
Cardiff Council
Carmarthenshire County Council
Caerphilly County Borough Council
Ceredigion County Council
Denbighshire County Council
Flintshire County Council
Cyngor Gwynedd

Merthyr Tydfil County Borough Council
Monmouthshire County Council
Neath Port Talbot County Borough Council
Newport City Council
Powys County Council
Rhondda Cynon Taff County Borough Council
City and County of Swansea Council
Torfaen County Borough Council
Wrexham County Borough Council

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RenewableUK Cymru Onshore Developers Group

Following a PAG meeting, Mace was invited to lead a session at the Onshore Developers Group meeting. Attendees were representatives from a range of organisations across Wales with a focus of onshore wind projects. Mace wanted to create a forum for open discussion and conversation and so asked attendees for their input on the wider research question of tensions and challenges that will arise of a 2050 renewables Wales from the onshore developer's perspective. We also tested themes that we had identified from previous engagement workshops to determine whether these themes were similar and again to get the perspective on these themes from a developer.

Individual Engagement

Private Sector Organisations

Mace conducted individual interviews with private sector organisations to gain their perspective on the challenges and tensions that occur. These organisations were selected as they have direct experience in developing renewable energy projects in Wales and range from smaller scale developers with direct experience of the project process (from inception, completion and in use) to industry leaders that are looking to future proof. The organisations engaged with included the below:

Uniper	RWE
EDF Renewables	RES
SNRG	Zestec Group

Welsh Government departments – Energy and Planning teams

Mace engaged several times throughout the course of the commission with the Welsh Government Energy Team. We also held a session with the Planning Team to investigate challenges of the planning process from another perspective.

Through the Welsh Government Energy team, we also engaged with Local Partnerships and Energy Systems Catapult.

All workshops and individual engagement sessions were conducted online. Outputs from the sessions have been recorded and can be found within the research and data pack.

Evaluate

Mace has used the information gathered from the policy review, data analysis and stakeholder engagement to theme the tensions and challenges. Once we had identified themes, we plotted key challenges and tensions across a project timeline from the Strategic Context to 2050 and beyond. We have also identified the challenges on both a local level and in different sections of the economy. Once we had the timeline, we used our early engagement to develop several key lines of enquiry which we explored further in the later engagement activities.

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Advise

In this final report, Mace has provided recommendations based on our review of policy, planning, and consenting as well as information gathered from our stakeholder engagement sessions. We have also identified what the benefits would be of implementing the recommendations. We have identified some of the levers, drivers and blockers to implementation and have explored the governance arrangements between central and local government and aligning policy with the regional planning bodies. Once we had a draft version of this report, we presented it to NICW and the Project Advisory Group (PAG) to gain feedback.

We have provided NICW with a “data pack” containing further research and information to support our findings in this report.

S T R A T E G I C
C O N T E X T

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Strategic Context

Introduction

This section provides an overview of the challenges and opportunities faced by Wales to reach its Net Zero targets from the infrastructure perspective, whilst providing global context to better understand the challenges required for a successful energy transition. Once an understanding of the energy transition has been built, it can be looked at in the context of the energy trilemma. Further context has been provided through an overview of the relevant geopolitical and macroeconomic landscape.

The Strategic Context introduces recent policy and regulation developments by providing an outline of UK wide decarbonisation policy developments and reviewing the Welsh Governments approach towards meeting their carbon reduction targets as outlined in the 'Welsh Net Zero Carbon Budget 2' and the 'Future Wales: The National Plan 2040'. This provides the foundation for which to build understanding of how Wales aims to implement its strategy towards delivering Net Zero from a Government and infrastructure perspective.

Beyond this, significant needs and trends related to renewable energy deployment will be outlined followed by the identification of the tensions and opportunities, outcomes from the stakeholder engagement and our recommendations.

Overview of the Energy System

The challenges and opportunities posed by the significant rollout of renewable energy are not confined to considering renewable energy projects as independent entities. To fully appreciate challenges and opportunities imposed, renewable energy projects must be recognised and evaluated within the context of the wider electricity and energy system. To better understand this, the diagram below outlines the high-level overview of the key components of the energy system.

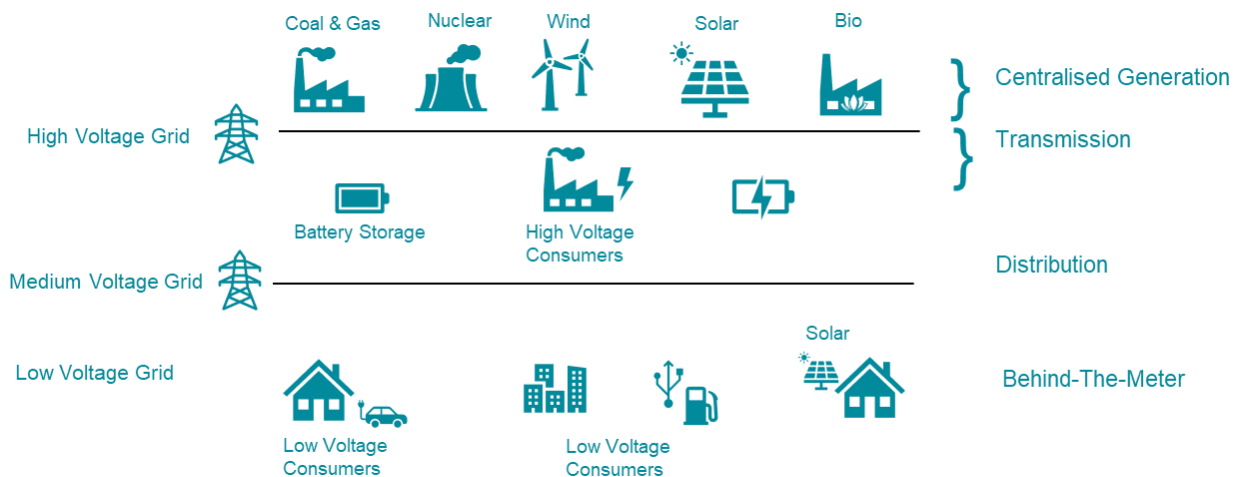


Fig 3: key components of the energy system

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The Energy Transition

The Energy Transition refers to the global shift from traditional fossil fuel-based energy systems to cleaner and more sustainable sources of energy. The primary goal of the transition is to reduce greenhouse gas emissions and mitigate the effects of climate change. Global warming has become an increasingly pressing issue on society in the last 15 years or so with governments from around the world setting carbon reduction targets and implementing strategic roadmaps to meet these targets. The U.K introduced the original Climate Change Act in 2008 and has since set targets, policies and proposals to reduce carbon and greenhouse gas emissions. The Energy Transition creates global challenges, which is driven by a variety of factors -

Factors Driving the Energy Transition

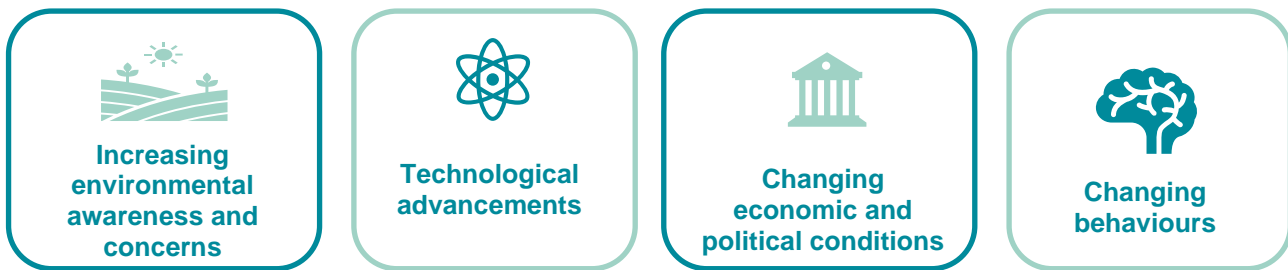


Fig. 4: Factors Driving the Energy Transition

Impacts of the Energy Transition

The energy transition has significant implications for the global energy industry, governments, businesses, as well as individuals and demands a multifaceted shift change in approach.



A seismic shift away from fossil fuels towards renewable energy sources such as solar, wind, hydropower and nuclear.



A fundamental shift in policy development and investment landscape to encourage the adoption of renewable energy technologies, energy storage solutions, and the implementation of energy efficiency measures.



The management of the intermittency of renewable energy resources and integrating these into the existing energy system.



Extensive collaboration between governments at national, regional, and international levels.



Extensive private sector collaboration to organise, invest and deliver renewable energy projects and programmes.

Fig. 5: Impacts of the Energy Transition – World Energy Council

Whilst the energy transition is a global issue, the challenges ahead provide significant opportunities for governments, businesses, and communities alike. The Welsh Government will require a comprehensive understanding of the complexities and multifaceted nature of the transition to collaboratively and effectively

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implement their road map to Net Zero . Whilst current approaches are predominantly top down, the Welsh Government wishes to incorporate the views and concerns of communities, imposed by the rollout of renewable energy and related infrastructure, through a whole system led approach.

The Energy Transition Against the Macroeconomic and Geopolitical Backdrop

To accurately understand the range and scale of the challenges and opportunities facing the energy transition and the rollout of renewable energy projects, it is important to acknowledge the macroeconomic conditions as a contextual backdrop.

Four major themes emerged from 2022 as a result of Covid19 and the Russian Invasion of Ukraine.





-  **Political Tension** – The invasion of Ukraine has signalled an abrupt end to the stability of the post-cold war era.
-  **Stagflation** – Rising commodity prices have caused accelerating inflation and decelerated growth, with global growth outlook slashed.
-  **Energy Scarcity** – Shortages of Russian pipeline gas has caused gas prices to surge beyond historical values.
-  **National Resilience** – Governments have placed renewed importance on the imperative of Energy Security due to confidence in global supply chains being shattered.

Fig. 6: Macroeconomic and geopolitical themes

This has accelerated the UK and Europe’s energy transition as it has created an environment for renewables to become more feasible. Taking Europe as a measure, the crisis has created an environment for renewables to represent 68% of the 2030 generation mix up to 200TWh from pre-crisis. This has major implications on the expected future rate of rollout of renewable energy projects throughout Wales compared to historical trends.

The Energy Transition and the Energy Trilemma

Regulation of the domestic energy market is a key responsibility of national government to ensure the secure operation of industry and society, but there are often tensions around the different outcomes or priorities of these policies. The World Energy Council's Energy Trilemma can be a good way of conceptualising the three energy policy concerns, which are often difficult to reconcile and in conflict to each other. The Energy Trilemma integrates and recognises the dynamics between energy affordability, energy security and energy sustainability.

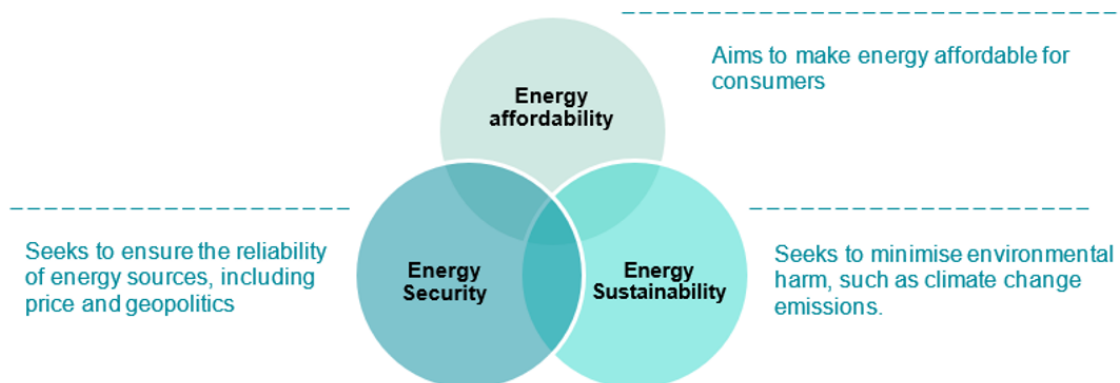


Fig. 7 The Energy Trilemma

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Building National Resilience

Building national resilience makes up a significant part of the answer to the 'Energy Trilemma' and a successful energy transition that delivers on the strategic decarbonisation objectives set.

As a result of inflation and supply-demand imbalance, current trends are displaying a heightened need for more available energy sources, as well as clear mitigation of high energy prices. This is vital to ensure energy remains affordable in every region. As organisations and governments progress through 2023, this presents a key challenge for Wales, and the priority will be to implement the strategies that can create a secure, sustainable, and affordable supply of energy while also keeping society on the path to Net Zero .

The path to developing a national resilient energy supply is complex and difficult but has key themes and challenges. The diagram below summarises this, whilst also providing the geopolitical tensions in terms of demand and supply shock for the imposed solutions to its consequences.

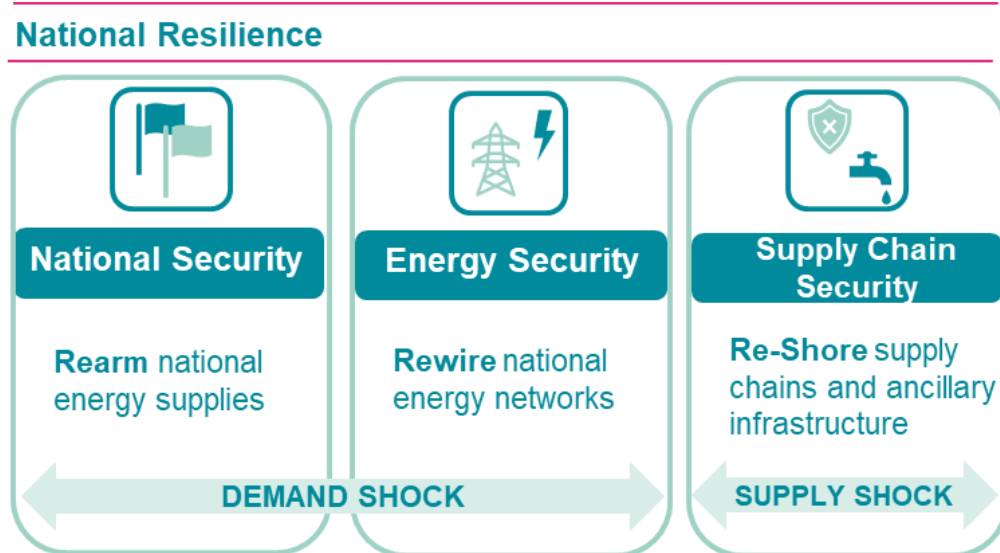


Fig. 8: Challenges of a nationally resilient energy supply

National Security: Through developing energy storage systems and arming energy supplies, these systems can help to store surplus energy during times of low demand which is then released back into the Grid during times of high demand or emergencies. Energy storage systems can help to provide backup power during grid outages, which can help to maintain critical infrastructure and services.

Energy Security: One of the best ways to ensure national security is by diversifying the sources of energy generation. This involves developing a mix of renewable and non-renewable energy sources, as well as investing in energy efficiency measures. Diversification of energy sources reduces the reliance on a single source of energy, which can help to mitigate the impact of disruptions or emergencies.

Supply chain and Infrastructure Security: Investing in infrastructure helps to ensure that energy can be reliably delivered to consumers, even during times of disruption or emergencies. Additionally, by onshoring supply chains and value chains, value can be obtained nationally and provide significant opportunity for levelling up and upskilling.

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Policy Development

Since the signing of the Paris Agreement at COP21 in 2015, the UK is committed to achieve Net Zero emissions by 2050. As a result, there has been an increased focus on initiatives, strategies and programmes to realise this ambition.

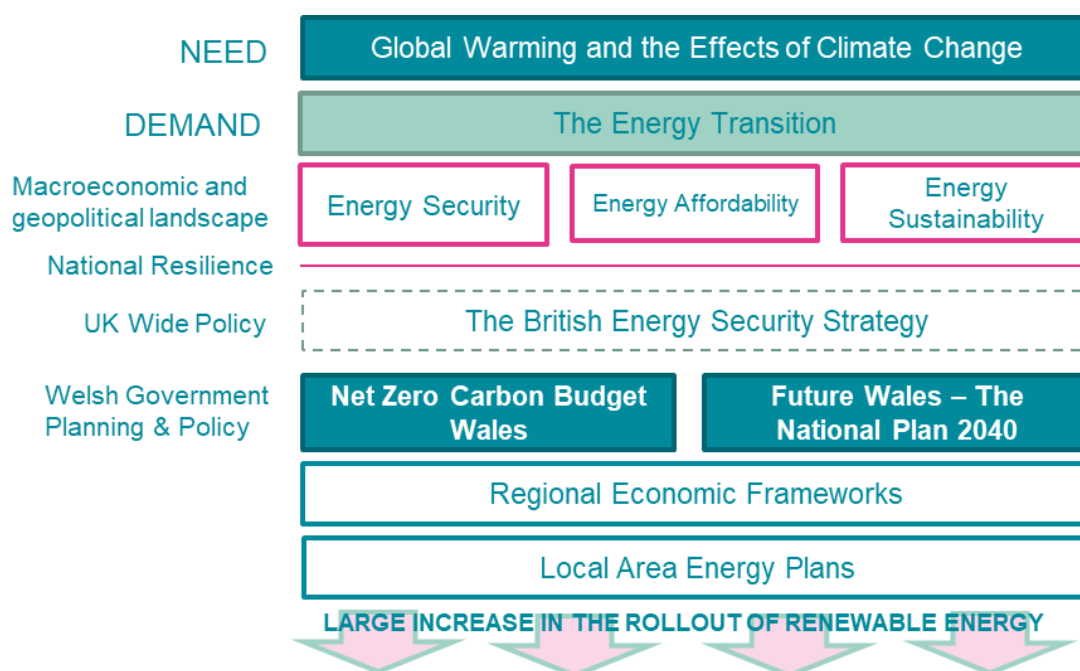
Welsh energy policy has been focused around the Net Zero Carbon Budget Wales, which builds on two main pieces of legislation, the Well-being of Future Generations (Wales) Act (2015) (WFG Act) which aimed to provide a comprehensive framework for sustainable development in Wales and the Environment (Wales) Act 2016 which mandates the Welsh government to reach Net Zero by 2050.

Energy policy in the UK is the responsibility of the Department for Energy Security and Net-Zero (previously under Department for Business, Energy and Industrial Strategy (BEIS)). Although there are numerous regulators much of the energy market is regulated by Office of Gas and Electricity Markets (Ofgem). Historically, parts of energy generation, transportation, and supply were run by the public sector. However, most of the market is now privatised where the generation and supply are competitive with transportation through networks is regulated as the operators are monopolies. The UK Government and Ofgem continue to regulate the market for customers and deliver policy to meet the Government’s aims on energy. Energy policy of recent governments has recognised the Energy Trilemma and therefore centred new policy around three objectives: security, affordability, and sustainability.

Since 2017, energy policy has been focused on aligning to the governments Green Growth Strategy. At the end of 2020, a Ten Point Plan for a Green Industrial Revolution and the Energy White Paper: Repowering our Net Zero Future, were published with new policies and commitments across many facets of the energy system including consumers, power, the energy system, transport, buildings, industrial energy, and oil and gas.

Top-Down Strategic Framework for Implementing the Energy Transition

Our analysis has shown how global warming and the effects of climate change have created the demand for The Energy Transition. Then, through imposing current macroeconomic and geopolitical context, the emergence of the Energy Trilemma and the need for National Resilience has been obtained. This derives the full picture for which to understand the evolution and convergent nature of UK and Welsh decarbonisation and planning policy and the challenges to which it aims to answer. This has been depicted in figure 9 below and shows how this has then imposed the large increase in the rollout of renewable energy.



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Fig. 9: Energy Transition – Strategic Framework

Energy Strategies

UK Wide Decarbonisation Strategies

British Energy Security Strategy

The British Energy Security Strategy is essentially Britain's answer to the energy Trilemma and building national resilience. It recognises the challenges posed by the current macroeconomic and geopolitical landscape, previously introduced, and outlines the plan for successful British Energy Transition. This strategy aims to solve wide ranging problems facing the energy industry, such as long licensing periods and red tape and accelerate the roll out of renewable energy systems with the aim of becoming energy independent. An overview of these objectives is given below:

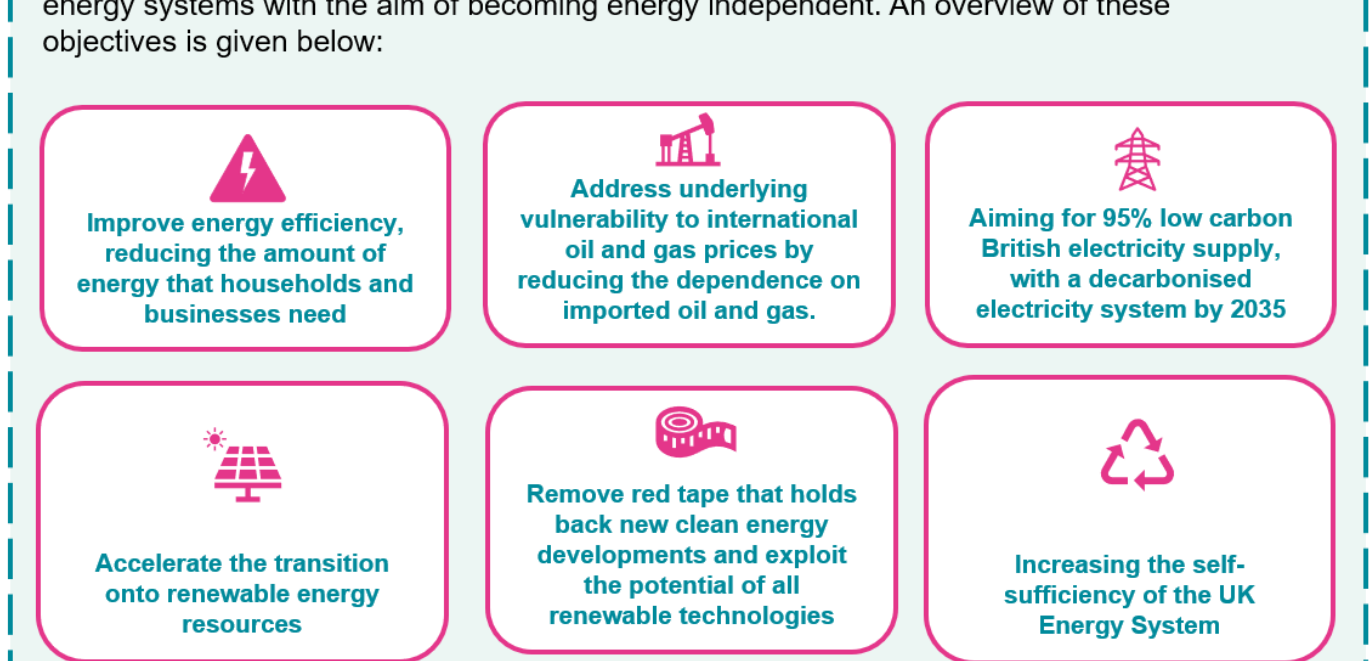


Fig. 10: British Energy Security Strategy

Welsh Government Strategies

Net Zero Carbon Budget 2 (2021 to 2025)

The Net Zero Carbon Budget 2 sets out 123 policies and proposals to deliver on a new phase for Wales and its journey towards Net Zero. The paper outlines a plan that sets out the commitments and actions required throughout Wales to deliver on its climate objectives in line with the advice from the Climate Change Committee (CCC). The transitional pathway aims to unlock a green future in Wales without leaving industries, communities, or businesses behind, thereby building economic prosperity which is fair and built on the wellbeing of the entire economy.

The below policies have been identified from the Net Zero Carbon Budget 2 as key policies relating to planning and development of renewable energy infrastructure. These have been used to support some of the recommendations made in this report.

- Policy 20 – De-risking and integrating investment in Wales through energy planning
- Policy 21 – Planning the delivery of the electricity and gas grid we need for Wales
- Policy 22 – Increasing renewable energy developments on land through our planning regime

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- Policy 23 – Consenting storage projects to support a flexible and responsive energy system
- Policy 26 – Locally owned energy developments to secure an economic return for Wales
- Policy 34 – Land Use Planning
- Policy 49 – Piloting smart, flexible and digitalised systems to [maximise use of assets] and help reduce demand

Future Wales – The National Plan 2040

This national development framework document sets the direction in Wales to 2040. This sets out a strategy for addressing key national priorities through the planning system including sustaining and developing a vibrant economy, developing strong ecosystems, achieving decarbonisation goals, and maintaining the health and wellbeing of communities. At its core the plan is a spatial plan, which identifies where investment in infrastructure and development should be focused to maximise benefit to Wales. The plan also aims to deliver on the commitments made by the Well-being of Future Generations Act 2015 to develop and improve the economic, social environmental and cultural well-being of Wales.

Future Wales is one of several documents concerned with infrastructure and development in Wales. However, the specific purpose of this document is to ensure the planning system is consistent at all levels and supports the delivery of Welsh Government strategic aims and policies. It has been shaped by a number of pre-existing policies for which it aims to provide further direction (Transport Strategy, Prosperity for All: Economic Action Plan, Natural Resources Policy and the Low Carbon Wales plan) all with the key objective of ensuring investments in infrastructure and development contribute to greater well-being and the creation of better places.

Deploying a More Integrated Net Zero Energy System

A key aspect of both Carbon Budget 2 and Future Wales is the change in approach required to increase low carbon and renewable generation through planning for a more integrated Net Zero energy system.

A document of particular interest is Scotland's recent publication of Scotland 2045 – Fourth National Planning Framework. This highlighted that a place-based approach is at the heart of creating a more sustainable and fairer Scotland. The planning system should apply the Place Principle which commits to taking a collaborative place-based approach to future energy infrastructure development, with involvement of stakeholders and local communities from early stages.

This policy emphasises the need to deliver an affordable Net Zero energy system by “Pursuing a joined-up whole systems approach – and ensuring full public engagement across the whole spectrum of actions needed.” This approach has been rolled out through the four Regional Energy Strategies which have been commissioned to start establishing a picture of the regional priorities for low carbon energy systems across 3 Net Zero pathways: power, heat, and transport.

The policy will be implemented through Regional Economic Frameworks (REF's) that build on the understanding developed by the regional energy strategies. The REF's make up a core element of the regional economic development strategies and include comprehensive engagement with local stakeholders and local authorities.

The REF's will then be developed further through the LAEP process that aims to inform a more detailed approach to implementing a decarbonised local energy system.

Using information crucial to the successful Welsh rollout of renewables and ancillary infrastructure from these documents, we have identified the following principles below that could be introduced to approach . These principles have been derived from some of the policies introduced in Net Zero Carbon Budget 2

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To deliver a smart and successful energy system, planning could use a **top down, regionally planned and market driven approach** which is more likely to facilitate the speed of delivery required by the climate emergency whilst also ensuring **cost optimisation and socially just systems that benefit entire communities.**



Encouraging the adoption of **whole-system energy planning approaches** that identifies the changes needed to the local energy systems across heat, transport, and local renewable energy production, whilst considering the future requirements of industry.

Fig. 11: Principles critical to the Welsh rollout of renewables and ancillary infrastructure.

SECTION 1: FEASIBILITY, DELIVERABILITY AND PROJECT CONCEPTION



1 Feasibility, Deliverability and Project Conception

1.1 Introduction

Feasibility and deliverability are critical to project conception and are what private developers will consider at the outset of their projects. Project Conception includes the consideration of site identification, understanding “place”, and the commercial viability of a scheme could be.

This section of the report will cover the tensions and challenges related to feasibility and deliverability under the headings used by HM Treasury in their ‘Green Book’ approach to business case development. Through our initial stakeholder engagement several lines of enquiry were identified that we further expanded upon in the later stages of engagement.

Headings	Lines of enquiry
1. Strategic	<p>Is there a clear roadmap to translate the ambition into a clear delivery model?</p> <p>At what stage of the process can potential investors and developers get a view on the likelihood of their scheme being successful?</p>
2. Economic	Is there a system in place that allows the prioritisation of projects and schemes that will provide the most benefit to the economy in Wales?
3. Commercial	<p>Are there enough benefits and incentives for investors to commit to, and remain committed to, projects in Wales throughout the timeline?</p> <p>How is the risk managed throughout the procurement process with the limited capacity of infrastructure, workforce and skills?</p>
4. Financial	How can investment in renewable energy in Wales be facilitated by Welsh Government and others?
5. Management	How can all stakeholders maintain delivery confidence across time, cost and quality indicators to ensure that the whole portfolio of schemes brought forward achieves Net Zero in 2050?

Table 2: Feasibility, Deliverability and Project Conception Lines of enquiry

1.2 Tensions and opportunities from research and stakeholder engagement

Several challenges and tensions became apparent through our research and stakeholder engagement, some of which span across multiple stages of the timeline. This section focuses on the tensions and challenges that predominately sit at the beginning of the project lifecycle.

1.2.1 Strategic

Welsh Government has an unequivocal ambition to achieve Net Zero by 2050 and this ambition underpins many policies. There was praise for this approach from almost all stakeholders however many stakeholders felt that there wasn't a clear roadmap or delivery plan of how this could be achieved. There is no Welsh Energy Strategy or Policy and tensions arise from a lack of consistency and uncertainty around the overall picture for Wales. It is acknowledged that there has been work commissioned via Catapult to create renewable energy scenarios and Phase 2 of this work, due April 2023 will; establish a small number of whole system energy scenarios (between 3 and 5) for the Welsh energy system; undertake whole system modelling based on the agreed scenarios and develop an 'Action Plan'.

1.2.1.1 Strategic investment context

There is a very positive upside case in that renewable energy market is a rapidly developing. It is characterised by high levels of innovation, competition, new technologies and emerging business models. The market is dependent on a range of financial mechanisms and policy frameworks, which have significant impact on the investment incentives of renewable energy projects and the growth of the sector. Therefore, it is important to consider key aspects of the current investment landscape, encapsulated by the following:

- **Higher Capture Prices** - Recent higher Capture Price (the price that electricity generators receive for the power they generate) have incentivised increased deployment of renewables across technologies. The costs, or otherwise the Levelised Costs of Electricity (LCOE) are heavily outweighed by capture prices giving significant profit growth and encouraging further investment into renewables.
- **Increased Demand for Storage Assets** – Energy Storage Facilities (ESF) are a critical solution to the rollout of renewables & the inherent intermittency and flexibility issues. Business case for storage projects in the UK has been positively impacted by significantly higher gas prices throughout 2022, which has increased investor appetite in demand storage developments. According to a Senedd research article, Wales currently contributes to approximately half of the UK total storage capacity, most of this through the hydroelectric storage facilities, Dinorwig and Ffestiniog. Battery storage is another option and also has the advantage of a higher efficiency as less energy is lost during storage. An example of where this has been used well in Wales is the 22MW battery co-located at the Pen y Cymoedd Wind Farm.
- **Availability of CfD and PPAs** - Investor confidence in renewable energy projects has been boosted in recent years by the availability of markets for Contracts for Difference (CfDs) and Power Purchase Agreements (PPAs). By providing greater revenue certainty and reducing risk for investors, CfDs and PPAs have helped to attract more investment into renewable energy, which has helped to drive down costs and accelerate the deployment of renewable technologies. Rises in the LCOE can be passed on to PPA / CfD arrangements.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

While the renewable energy market remains strong, with rapid growth in recent years, there are many potential downside risks which affect investor confidence in renewable energy deployment.

- **Regulatory Uncertainty** – Regulatory environment is complex and subject to change - Changes to regulations related to interconnection, net metering, or grid access could impact the viability of renewable energy projects.
- **Dependence On Government Policies** - Renewable energy market is highly dependent on government policies and incentives, which can be subject to changes in political priorities or budget constraints.
- **Grid Connection Challenges** - Integrating high levels of renewable energy into the grid requires significant investments in transmission and distribution infrastructure, ESF, and demand-side management.
- **Technological Innovation** - The pace of technological change is rapid, and there is a risk that new technologies could emerge that could make current renewable energy technologies obsolete.
- **Supply Chain Risk** – Renewables are reliant on global supply chains that includes raw materials, manufacturing, and transportation. Disruptions in the supply chain due to factors such as geopolitical risks, trade disputes, or natural disasters could impact the availability and cost of renewable energy technologies

1.2.1.2 Challenges and tensions

According to the Climate Change Committee (CCC), electricity demand in Wales and the U.K is expected to double by 2050. To meet this growing demand, a more joined-up approach is required across the regulator, developers, system owners and operators. This will ensure that required infrastructure developments and upgrades can be made to anticipate the acceleration of rollout of renewable energy projects.

Developers told us that it was very difficult to engage with DNS officers at a pre-application phase of the Developments of National Significance process as they would submit their applications without any oversight and then receive feedback. There is also a lack of engagement from Local Planning Agencies (LPAs) to support developers. This supports the suggestions of a resourcing issue within the pre-applications stage and a lack of incentive for LPAs to assist developers. The DNS process is explored in further detail in section 3. This leads to a lack of investor confidence as it means that the investor doesn't have a clear oversight on the likely success of a potential project without undertaking a significant amount of work and incurring costs upfront. Other stakeholders told us that the Infrastructure Consenting Bill, to be adopted in 2025, will address some of these concerns so how the ICB is implemented will be important.

Stakeholders found that they needed to navigate through different documents to find the Welsh Government's energy strategy, therefore it is important that there is a clear roadmap and strategy (as outlined in Recommendation 1.1).

“(There is a) lack of consistency and clarity. This is needed at all levels on objectives as the roadmap to Net Zero for 2050 is very unclear. We don't have a clear roadmap to 2050. We're not clear on what role onshore wind and solar will play after 2050. There is not a single message right through - this reflects ambiguity in overarching policy.”

- Large renewable energy provider

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

1.2.2 Economic

1.2.2.1 Economic context: Regional Economic Frameworks

Regional Economic Frameworks are strategic documents that form an essential part of the Welsh government's commitment to a more focused model for economic development that incorporates the individuality of the regions whilst focusing on sustainable growth and maximising opportunities to address inequalities on a local, regional, and national level. By 2025, the Welsh government aim to incorporate this into new City and Growth Deals that have carbon reduction as a core aspect of economic development, encompassing all the relevant targets, outputs, key metrics, and monitoring measures to enforce this. The REFs cover North Wales, Mid Wales, South West Wales and South East Wales.

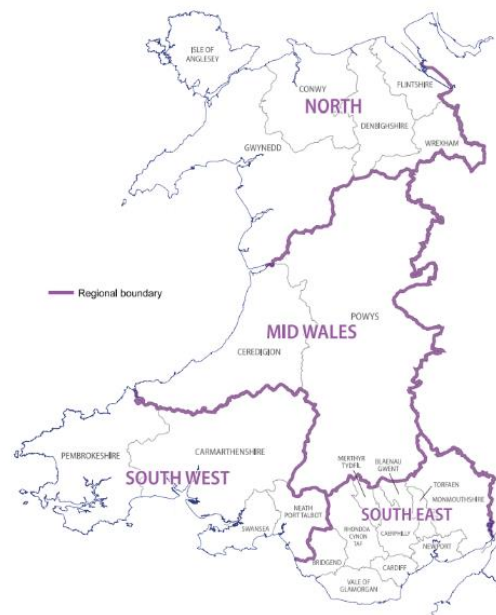


Fig. 12: Regional map of Wales

Each region has its own distinctive opportunities and challenges and through embracing these through more effective regional collaboration will lead to better outcomes for all parts of Wales and create a fairer distribution of wealth and opportunity.

A key goal for the City and Growth Deals is to unlock the additional funding to support interventions to develop sustainable economic development, through promoting collaboration between the public and private sector.

1.2.2.2 Economic context: Local Area Energy Planning

Local Area Energy Plans builds on the Regional Energy Strategies by taking a more detailed approach to identify the actions to decarbonise the local energy system. The overarching aims of the process are to inform, shape, and enable key elements of the transition to a low carbon energy system. The plan aims to identify what, where and when needs to happen by incorporating consumer transformation pathways across energy efficiency retrofit, heating, transport, and wider economic development. The plans aim to gain a comprehensive understanding of the current local energy system, including consumers, grid capacities and network providers plans and then forecast the transition of this towards a Net Zero end goal. Through techno-economic modelling, it outlines the stages and scale of interventions required and the associated cost models with implementing this.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

1.2.2.3 Challenges and tensions

It is hard for stakeholders to see how schemes are prioritised across the whole timeline. There appears to be no process to prioritise schemes which are going to achieve the largest benefits for the population of Wales at either a local, regional or national level. Putting in place a layer of governance surrounding the pipeline of projects requiring consenting and investing that adds value to all parties rather than creating delay may be helpful to allow a helicopter view at a national level.

Tensions arise from communities feeling that they are unfairly disadvantaged by having schemes in their area and can't see the clear benefits of investment in renewable energy infrastructure. Young people reported that there was significant work to be done to persuade communities of the benefits of renewable energy across all generations, both at a macro level and at an individual behaviour change level. A change in the mindset of the public is needed to ensure that once schemes enter the public domain they are not immediately met with negativity and resistance. The wider economic benefits related to jobs, employment and health are not largely recognised by communities so their focus is often on how a scheme might negatively impact them.

In June 2022 Statkraft, Europe's largest renewable energy generator, conducted a study of 18,000 people across 9 countries. They found that more than two thirds (69%) think renewable power development should be prioritised further considering climate change concerns and the ongoing energy supply crunch. Almost a quarter (23%) said their perception of renewable energy had become more positive in the last six months and overall, an 80% and 87% acceptance rate for onshore wind and solar power development respectively was recorded from the respondents. Whilst not specific to Wales, this shift in attitudes shows that the opportunity to demonstrate the wider benefits is clearly present.

Linking the socio-economics benefits to the UN Sustainable Development Goals is one way in which the Welsh Government could address changing public perception and awareness.



Fig. 13: International Renewable Energy Agency (IRENA): Renewable Energy Benefits; Understanding the socio-economics

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

1.2.3 Commercial

Many of the developers we spoke to as part of our stakeholder engagement told us the same or similar things around the tensions and challenges of delivering projects in Wales. The single biggest tension is around the time it takes from conception of a scheme to being brought into use. With timespans of up to 15 years (in part due to the major issue of grid connectivity which is covered in section 2 it is difficult to see why investors would choose to invest in Wales). Developers told us about the comparative benefits of the Scottish Government systems and whilst Welsh Government cannot undo the consequences of decisions taken in the past by the UK Government it was suggested that there is opportunity to increase speed and develop sector deals for technologies.

1.2.4 Financial

1.2.4.1 *Investor confidence*

To fully understand the challenges and tensions posed by a significant increase in the rollout of renewables in Wales, it is important to understand the current market conditions in terms of investor confidence and the investment landscape.

A key part of addressing the challenges facing the significant increase in rollout of renewables is to ensure the power markets are fit for purpose over the period to 2035 and beyond. Requirements for this include:

- A faster scale up of low carbon technologies
- Unlock unprecedented levels of investment across the full range of low carbon technologies
- Driving innovation across the energy sector
- Onshoring highly skilled jobs and supply chains
- Ensuring that the network can be operated safely, and cost-effectively as variable renewables come to dominate the capacity mix.
- Growing the domestic renewable energy supply, reducing the reliance on energy imports, and managing the electricity system needed to support this

1.2.4.2 *Market design shifts*

Market design shifts in the electricity market can be implemented through various policy tools, including levies, cost limits, and taxes. These tools can help to incentivise market participants to adopt new behaviours or technologies, or to correct market failures that can inhibit the development of a more efficient and sustainable electricity market.

- **Levies:** Levies can be used to raise revenue to support the development of renewables and other low-carbon technologies.
- **Cost limits:** Cost limits can be used to regulate the price of electricity in the market to prevent excessive price increases.
- **Taxes:** Taxes can be used to generate revenue or to incentivise behaviour changes. A key element of this could be to encourage market participants to innovate and increase the rate of adoption of new technologies. Fiscal devolution in Wales under The Wales Act 2014 and 2017 allows this to be considered.

Stakeholders reported that facilitating additional investment vehicles and the feasibility of a Net Zero furlough could be potential options to incentivise investment.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

1.2.4.3 Locational pricing

Locational Pricing is a pricing mechanism for electricity that considers the location of electricity generation and consumption. In traditional electricity markets, electricity is priced uniformly across a geographic region, regardless of where it is generated or consumed. Whereas in locational pricing seeks to reflect the costs of transmitting electricity over long distances and the congestion on the electricity grid that can occur in some areas. The Catapult report 'Location, Location, Location' sets out the areas in Wales where this would be helpful.

Locational pricing can have both positive and negative effects on renewable energy deployment, and it is important to carefully consider the design and implementation of locational pricing mechanisms to ensure that they support the deployment of renewable energy in a cost-effective and sustainable way.

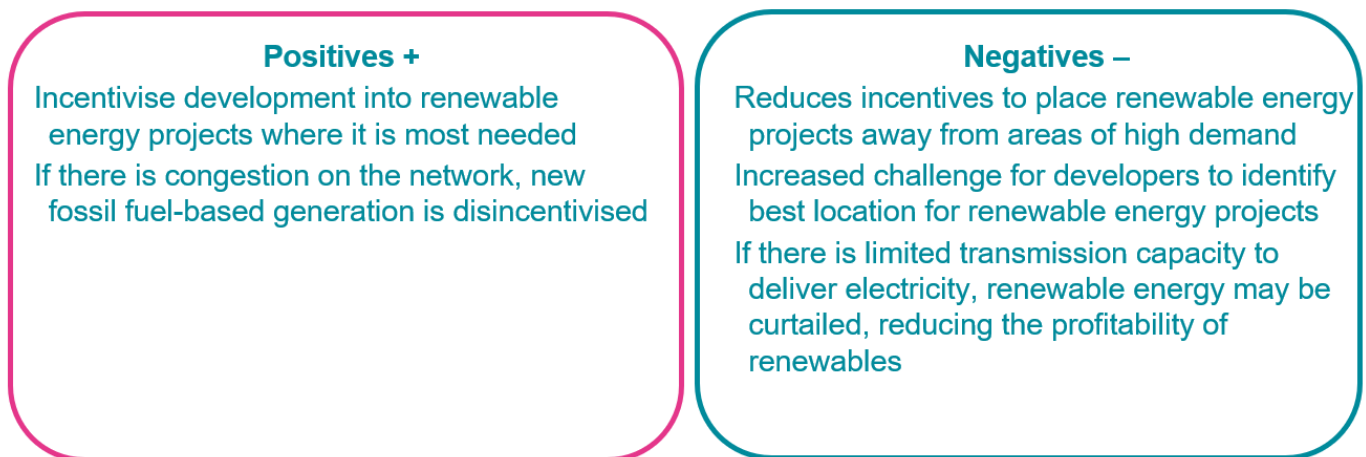


Fig. 14: Positive and negative impacts of locational pricing

1.2.4.4 Capacity of the network

The National Grid Electricity System Operator (NGESO) Network Option Assessment (NOA) is a process designed to evaluate and identify the most appropriate network solutions to accommodate renewable energy projects on the UK's electricity grid. It provides recommendations around which network reinforcement projects should receive funding, and in what order.

- Implementing a programmatic approach towards renewable energy projects and ancillary infrastructure.
- Implement a pipeline of renewable energy projects and required network connections.
- Enables transparent governance in a dynamic energy environment.
- More informed decision making, more investor and developer certainty
- Ensures delivery needs can be prioritised in response to current system requirements and helps encourage the rate of rollout of large infrastructure development.

1.2.5 Management

“ There is a transitional period and a risk from Welsh Government of letting perfect be the enemy of the good. There are important steps forward that we need - being pragmatic is important. We need to acknowledge the polarity in the energy transition.” **International clean energy generator**

1.2.5.1 Connection to the network

The National Grid Electricity System Operator (NGESO) Transmission Entry Capacity (TEC) Amnesty is a mechanism introduced by the UK government to remove stalled projects from the connections register and free up space for projects which are progressing more quickly, thereby supporting the development of renewable energy projects.

This amnesty is a key enabler to planned revisions to the connections process, which will move away from a ‘first come, first served’ basis. The introduction of queue management arrangements will place greater responsibility on the developer to ensure that their projects progress on time and more importantly in line with the milestones they have committed to on their grid connection agreement.

The benefits of the amnesty on renewable energy projects include:

- **Reduced Costs:** The scheme allows developers to avoid significant financial penalties that could result from delayed grid connections. These penalties can be particularly challenging for renewable energy projects, as they often have tight budgets and timelines.
- **Increased Certainty:** By providing a temporary exemption from penalties, the NGESO TEC Amnesty provides developers with greater certainty about their project's viability. This can help to reduce the risk of project failure and can provide reassurance to investors.
- **Accelerated Development:** The scheme helps to accelerate the development of renewable energy projects by removing a significant obstacle to grid connection. This can help to increase the overall capacity of the UK's renewable energy sector and contribute to the country's clean energy goals.
- **Improved Efficiency:** The NGESO TEC Amnesty helps to improve the efficiency of the grid connection process by encouraging developers to secure planning permission earlier in the project development process. This can help to streamline the overall process and reduce the time and

This programmatic approach links to R1.2 below.

1.2.5.2 Benefits tracking

Stakeholders reported that the complex landscape of schemes across Wales makes it difficult to maintain delivery confidence across the whole project lifecycle. Without the system stewardship set out in R1.2 below, it is difficult for developers to retain confidence at a time of change from a geo-political, socio-economic, and internal organisational perspective. The potential benefits of schemes may get lost over time if they are not tracked, updated, and renewed during the potential 15-year lifecycle.

Feasibility, Deliverability and Project Conception Recommendations

R1.1 Creating a renewable energy infrastructure strategy

Create a clear and unambiguous strategy and roadmap around renewable energy and infrastructure across Wales, setting out the different scenarios and energy modalities and how and when this can be achieved. The strategy should include metrics to track the transition in real time and target support to areas where progress is not being made in line with the plan. This roadmap could include a maturity assessment of the four clusters to identify areas to target in the future roadmap.

The strategy should communicate clearly to the public what Welsh Government is currently doing to the whole energy system.

Benefit: Provides confidence that there is a plan for delivering on the Welsh Government ambition with the ability to track progress against the plan

R1.2 System stewardship

Welsh Government to set out the system stewardship requirements and governance framework for having a helicopter view across all renewable energy projects, managed by a Programme Board with representatives from Government, the Regional Economic Frameworks, District Network Operators, the Local Area Energy Planning Teams and the private sector who make recommendations and decisions around prioritisation of the schemes that will bring the biggest benefits to Wales. There is an opportunity to consider this through how the Infrastructure Consenting Bill is implemented in 2025.

Benefit: The transition to renewables happens more quickly as there is a clear system approach, prioritisation and governance framework in place.

R1.3 Changing public perceptions

Consider what Welsh Government, Local Authorities and other stakeholders can do to proactively change public perceptions by clearly articulating the economic, health, employment and energy benefits of investment in renewable energy at a community, regional and national level through a place economics and/or public health approach. There is an opportunity for Welsh Government to include a financial mechanism in the emerging Infrastructure Consenting process to help communities impacted by renewable energy initiatives to capture a portion of the financial benefit generated by public investment and policy decisions. This could involve the use of land-taxes and impact fees, which allow communities to collect revenue from new development and reinvest it in the local area.

Benefit: Raising awareness of the wider benefits of renewable energy and reinvesting in areas which can maximise the socio-economic benefits of investment in renewables, which may also be effective in reducing local objections to schemes

R.1.4 Potential investment vehicles to support investors and developers, and impact of locational pricing

Development of an Investment Commission to work with investors, developers, economists and the Welsh and UK Governments to review the potential investment vehicles both within and out with the devolution agreement. Consider with BEIS the potential impact of locational pricing and whether the benefits will outweigh the risks of implementing a locational pricing scheme.

Benefit: Attracts more investors/developers to become and remain committed in seeing projects through the full project lifecycle. Welsh Government will have a full understanding of whether locational pricing will incentivise development in the areas where it is most needed.

R1.5 Knowledge transfer

Consider what knowledge transfer is available from Scotland, elsewhere in Europe and the rest of the world to make Wales an investable proposition. Consider what can be done to improve the speed of the scheme lifecycle to secure investor confidence. This will inevitably require anticipatory investment in the grid and considering whether Welsh Government wish to influence OFGEM to allow DNOs to make more anticipatory investment in the grid (covered in further detail in section 2)

Benefit: Increases investor appetite in Wales and allows the lessons learned by other areas to expedite delivery.

SECTION 2: INFRASTRUCTURE



2 Infrastructure

2.1 Introduction

Infrastructure can take many forms – it can be defined in physical, green and community terms and is essential to support objectives of increased housing provision, economic growth and mitigating climate change, and of creating thriving and sustainable communities.

Energy, grid and renewable energy schemes, is considered as an infrastructure. Integrating different infrastructure demands to come together as part of an energy eco-system at a community, regional and national level can often cause tensions. As an example, the National Planning Policy Team in Welsh Government report that emails around renewable energy schemes fill their inbox by a factor of twenty.

Critical to the delivery of any scheme relating to renewable energy generation, distribution or storage, at any scale, is infrastructure. Having infrastructure capacity to enable a scheme or initiative is a pre-requisite. Without the relevant infrastructure, it is unlikely Welsh Government will be able to meet its 2050 Net Zero target.

Within this context, supporting and ancillary infrastructure constitutes:

- Overhead transmission lines – carry high voltage electricity from the generation source to an area where its required
- Electrical sub-stations – convert high voltage to lower voltage to enable transmission
- Distribution lines – lower voltage lines that carry electricity to its destination
- Transformers – increase/decrease voltage as it moves through the distribution network
- Control systems – required to monitor and respond to peaks and troughs in demand

Headings	Lines of enquiry
1. Grid Capacity	Is the capacity of the grid fully visible? Are there any challenges as a result of not having visibility?
2. Localised Grid Infrastructure	Are micro-grids a viable option? Will these form part of the future energy landscape? What are the challenges with a localised grid?
3. National Infrastructure Policy	How can we make policy more strategic? What do Welsh Government need to consider when making these changes?
4. Energy Storage	What role will energy storage play in the energy landscape? Do current policies support facilitation of energy storage?
5. Co-location of Infrastructure	What are the benefits of co-location of energy infrastructure? What can realistically be co-located?
6. Existing Infrastructure	What are the considerations when looking at potential expansion of the network?

Table 3: infrastructure Lines of enquiry

2.2 Existing infrastructure

From our research, it is believed that the Grid capacity within Wales is currently capable of distributing circa 85GW of power at any one time, although this is difficult to conclusively evidence. There is an uneven distribution of this grid capacity across areas as a result of infrastructure provision.

In 2017, the Welsh Government set a renewable energy target for:

- Wales to generate electricity equal to 70% of its consumption from renewable sources by 2030.
- 1GW of renewable energy capacity in Wales to be locally owned by 2030.
- An expectation for all new energy developments in Wales to have at least an element of local ownership from 2020.

Latest data indicates that in 2021 renewable sources in Wales generated the equivalent of 55% of electricity use against a target of 70% by 2030. In addition, Wales has achieved nearly 90% of its target of at least 1 GW of renewable energy capacity to be locally owned by 2030, representing an estimated 1.9 GWh of generation in 2021 (Review of Wales's Renewable Energy Targets, Welsh Government, 2023).

Information provided from the Climate Change Committee 6th Carbon Budget (2019) indicates that Welsh Electricity demand will increase from circa 15TWh to circa 40 TWh in 2050 (TWh is a terawatt-hour which is equal to 1,000,000 megawatt-hours). It is further projected that by 2050, Welsh renewable generation may only be equivalent to circa 20% of Welsh electrical consumption – i.e., circa 7TWh.

To meet these targets and the shortfall of renewable energy generation, geographic considerations will be required in relation to the 'top level capacity' of the infrastructure network. This means that significant improvements in infrastructure, specifically in mid-Wales where there is less developed infrastructure that helps to unlock renewable energy generation needs consideration, as this could result in developers having to consider alternative sites or approaches.

In July 2021, the Welsh government issued a report on Renewable Energy in Wales which concluded that developers of renewable energy were encountering problems with grid capacity and connecting to the electricity grid in Wales. Throughout 2022, the Welsh Government undertook an investigation into the grid and its capacity to meet current and future demands, which concluded the follow:

- The grid network has been built piecemeal over several decades to meet the energy needs of the nation.
- The government must take a more strategic and planned approach to the Network.
- Wales is not well-connected to other countries' transmission systems, which can limit the ability to export surplus renewable energy to other markets

2.3 Tensions and opportunities from Research and Stakeholder Engagement

2.3.1 Grid Capacity visibility

Site identification can prove to be a challenging process as the site will be subject to the consideration of several technical and environmental outcomes from a process of due diligence. This will consider grid capacity and timeframe to be connected, ecological impacts, commercial viability etc.

One of the tensions raised through our stakeholder engagement is that renewable energy developers do not have quick access to visibility of grid capacity in areas they are considering developing without applying to National Grid or SPEN, which leads to commercial insecurity. The current system requires a consent for renewable energy or an Energy Storage Facility (ESF) to inform where the Distribution Network Operator (DNO) implement Grid upgrades. The time-lag between the consent and the Grid upgrade can be up to 10 years in some instances, and so this time-lag was a significant source of frustration among the developers we consulted.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

The tension for developers and investors is once developers have submitted an application, only then can they understand the detail of the Grid capacity deficiencies, and what infrastructure improvements are required to unlock their projects.

The DNOs in Wales (National Grid for South Wales and SPEN for North Wales) will provide an offer of what developers can export or inform the project that they cannot connect. Otherwise the developer awaits connection (see paragraph 1.2.5.1).

2.3.2 Management of the ‘Net’ Infrastructure Requirement

From our engagement with developers, the onus was on the optimisation of the existing Grid infrastructure, while also maximising the benefits associated with unlocking strategic sites. The aim should be to reduce the burden on the Grid, capitalise on any ‘freed up connections or capacity’ and unlock additional access and capacity.

A consideration put forward related to Micro-Grids. It was proposed that these are an option for developers and industrial operators to generate and use their own supply. This requires ‘private grid network’ to be delivered that links to an energy generator that meets local demand. It was identified within stakeholder engagement that developing an “islanded approach” is a possibility where critical mass can be demonstrated – For instance in significant industrial clusters in the South. While it was agreed that this approach will not necessarily meet the growing energy demand, it could be used to reduce the demand on the current Grid capacity. The challenges with this are the reliability or consistency to customers/consumers and the unknown additional costs, as well as requiring grid access for back-up. Notwithstanding the level of generation that can be achieved.

However, policies for ‘off-Gridding’ significant industrial cluster consumers could be an option linked to the emerging Freeport status where there is a significantly de-regulated planning framework, where occupiers will benefit from tax-incentives on production, manufacturing, and implementation within the Freeport its self. This could be similar to the Teesside Freeport, where construction is underway at SeAH Wind Ltd.’s multi-million pound offshore wind manufacturing facility at Teesworks highlighting the role Freeports will play in attracting green investment.

2.3.3 Strategic National Renewable Energy Infrastructure Plan

The application process between developers and DNOs is changing due to increased pressure on the grid. It was proposed through stakeholder engagement with the Private Sector developers that Welsh Government should prepare a strategy relating to supporting infrastructure that could consider-

- How to effectively maximise the efficiency of the current Grid system
- Preparing a National Energy Infrastructure Strategy
 - Electricity
 - Gas
 - Hydrogen
- Where improvements to overhead cables network would maximise the release of land required for renewable energy generation sources
- Developing a Planning and Consenting regime that encourages supporting infrastructure to be included within the consent, without incurring significant delays to the decision, to facilitate delivery.

2.3.4 Energy Storage

The integration of large amounts of renewable energy into the grid can pose challenges for maintaining system reliability and capacity, as the grid needs to balance supply and demand in real-time. This requires careful management of the grid and coordination between different energy sources and grid operators. This also creates the need for grid scale energy storage to balance out fluctuations in supply and demand.

ESF (Energy Storage Facilities) will play an important part in supporting that grid as part of the renewable Wales 2050 picture. Energy storage should be viewed as a support to the grid and not in place of making upgrades. There is also opportunity for co-location of storage alongside renewable assets, although this will need to be connected for distribution. Storage would allow energy to be moved around at different times however, this will not solve the issue of increased demand.

Stakeholders informed that there is a lack of interconnectivity in North and mid-Wales and no existing plans to increase carbon capture and storage (CCS). Stakeholders have also commented that Welsh Government policies are generally supportive of storage.

2.3.5 The Co-location of Infrastructure

The 'co-location of infrastructure' is a term that has recently been introduced within the context of renewable energy deployment. The term refers to the practice of installing different types of renewable energy generation and storage technologies, such as solar and wind power with an associated ESF in the same location to derive benefits from both a cost and planning perspective. Co-location allows for a more efficient use of land, reduces the environmental impact of renewable energy projects, and can improve the overall economics of the project by sharing infrastructure and grid connections. As a concept, this was supported by both public sector and private developer stakeholders throughout the consultation process.

Co-location can also reduce the need for new transmission infrastructure and help to optimise the use of existing transmission lines, which can be costly and time-consuming to build, which relates back to the importance of Welsh Government understanding how to more efficiently release and utilise spare Grid Capacity within the regions. However, the overarching 'capacity' issue will need to be addressed to enable the colocation of ESFs to be beneficial to Welsh Government.

An example of where co-location has worked well within Wales is the Pen y Cymoedd Wind Farm in South Wales. As well as wind turbine, there is a 22MW battery located on the farm that provides a stable supply of electricity to the United Kingdom. It should be noted that this project benefits from using the existing wind farm grid export connection.

Through sharing infrastructure such as substations, roads, and other facilities, co-location can increase the commercial competitiveness when considered against traditional fossil fuel-based power generation, or stand-alone renewable energy generation.

2.3.6 Existing Infrastructure – Potential Future Expansion Strategy

Supporting infrastructure that facilitates the delivery of Net Zero targets must be considered in tandem with the projects and initiatives that will enable Welsh Government to meet its 2050 targets. Welsh Government must consider overhead cabling strategies (such a North-South Line), and gas and hydrogen pipelines to unlock vast areas of renewable energy delivery. This refers to the mantra "I before E", i.e., *infrastructure* must be in place before Welsh Government can *expand* its renewable energy resilience.

To rollout a large increase in renewables, Wales must recognise its strategic importance, such as its abundant Wind and Tidal Energy resources along the west coast but must also work to unlock these areas for development through infrastructure provision.

The rollout of renewable energy must be understood within the wider context for the requirements of the pathways to Net Zero . The Welsh Government, working with the Climate Change Commission and UK Government are beginning to understand the pivotal role that CCUS (Carbon Capture Utilisation and storage), and hydrogen ecosystems will have on enabling a successful energy transition. CCUS has the potential to enable the decarbonisation of many parts of the economy including industry, power generation and heating and transport. Hydrogen has the potential to support deep decarbonisation across multiple sectors in Wales, including transport, industry, domestic heat and power.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

Due to the interdependent nature of hydrogen and CCUS systems, Welsh Government must understand how existing energy networks in Wales can be used to enable this. It is expected that future hydrogen networks will largely replicate the current configuration (although not necessarily the same geographical topology) of the existing natural gas network.

The Regional Decarbonisation Pathways report, published by Wales and West Utilities in September 2022 highlights the following conclusions for future infrastructure expansion within Wales.

Although co-located energy production and demand was the approach followed in developing the original electricity and gas networks, over time the design basis gravitated towards more centralised production of energy at scale, which is then transported and distributed to the areas of demand. However, from the point of view of hydrogen supply:

- Establishing locations where hydrogen can be produced at scale is key to realise the transition to a low carbon gas network
- The location of early hydrogen production anchor projects is closely related to the place of consumption in industrial clusters
- The hydrogen generation capacity in these sites will increase in phases to support gradual decarbonisation in industrial clusters

According to the National Atmospheric Emissions Inventory (NAEI) database highlights that over three quarters of the industrial emissions associated within Wales and the South West are produced in South Wales by three emitters at two geographical locations (i.e. Milford Haven and Port Talbot).

1. Tata Steel Port Talbot
2. Pembroke Power Station
3. Pembroke Oil Refinery

The decarbonisation decisions which are taken by these three stakeholders are likely to have an extremely significant impact upon the decarbonisation solutions and infrastructure which is implemented within WWU's region in future (as well as when it is implemented).

Great Britain's Hydrogen Backbone

Future hydrogen infrastructure requirements across Wales must be understood within the wider 'Great Britain's Hydrogen Network Plan' network strategy which proposes a hydrogen backbone as part of Project Union. Britain's Hydrogen Network Plan includes a commitment to deliver a hydrogen network that meets the same high levels of supply security as today, with very rare unplanned interruptions; whilst Project Union aims to explore how to convert pipelines in a phased approach, identify pipeline routes, assess the readiness of existing gas assets and determine a transition plan for assets in line with Net Zero plans. An overview of the proposed hydrogen backbone is shown below in figure 15.

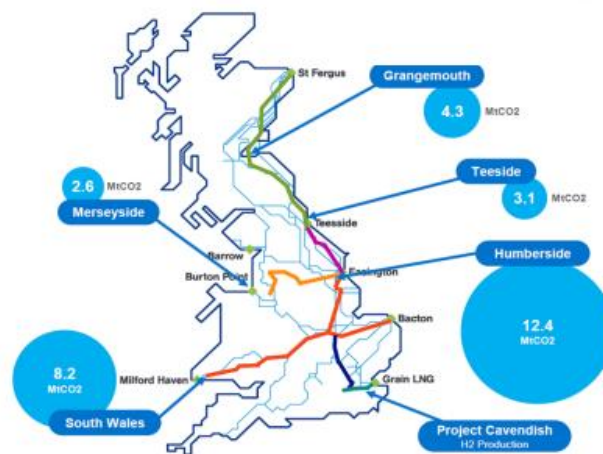


Fig. 15: Indicative Structure of the Proposed Hydrogen Backbone

The hydrogen backbone will connect the clusters of Grangemouth, Teesside and Humberside, the North West and South Wales industrial clusters to distribute hydrogen throughout the UK, linking sources, underground gas storage and end users.

The Wales and West Utilities 'Regional Decarbonisation Pathways' report, highlights the following implications for Wales.

- There is a huge practical value in the existing pipeline corridors and repurposing pipelines is likely to be far easier than introducing either new pipelines or building new electricity circuits for low carbon energy transfer.
- Future low carbon gas production locations may be located similar to present day LNG terminals or gas interconnectors with Europe).
- The hydrogen NTS ("hydrogen backbone", as developed by Project Union) will provide the main transmission infrastructure to transport hydrogen at high pressure and supply which large consumers (e.g. CCGT power plants) and gas distribution networks via offtakes.
- It is anticipated that security of supply will be supported by the injection of blue and green hydrogen into the hydrogen NTS from multiple sources, including clustered hydrogen production plants (e.g. at Milford Haven due to the site being an existing location of natural gas importation at scale) and interconnectors to the European gas or hydrogen network infrastructure.
- Regional blue hydrogen generation hubs will be required by large industrial demands in South Wales, particularly surrounding Port Talbot
- Requirement for a hydrogen pipeline linking hydrogen production in Milford Haven with the local gas network at the Dyffryn NTS offtake and potentially linking industrial clusters at Port Talbot and beyond.
- There are fewer NTS feeders running across WWU's region and therefore to realise parallel supplies of both hydrogen and natural gas, either localised blending (and potentially also deblending) facilities may be required.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

Key components of infrastructure, as shown below, includes Multi Product-Pipelines, Natural Gas pipelines, Oil Pipelines and Electricity Transmission lines will require repurposing, upgrading and reuse to support the required Net Zero Infrastructure Developments.



Figure 4-9 South Wales major pipelines and electricity transmission lines. Image courtesy of the Port of Milford Haven.

Fig. 16: Major pipelines and electricity transmission in South Wales

Below in Figure 18 is an overview of the future CO₂ import and export routes, making up a critical part of the CCUS network.

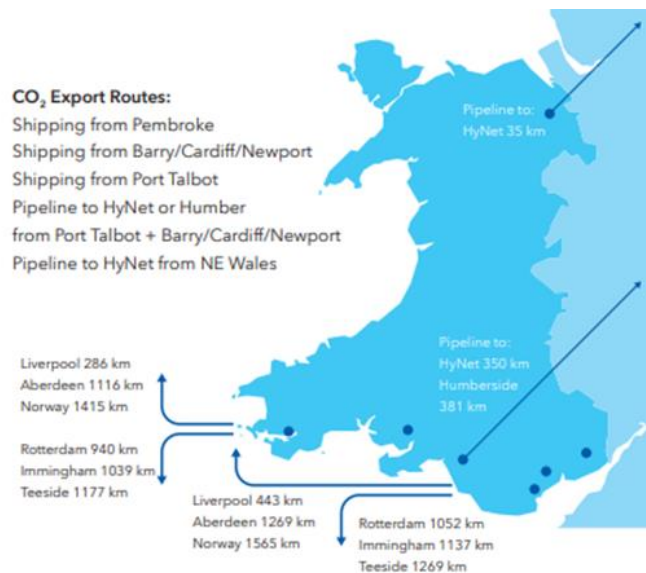


Fig. 17: Overview of the future CO₂ import and export routes

Welsh Government need to undertake a multifaceted approach to the future expansion of its infrastructure by linking up many of its strategic initiatives as it can into a consolidated National Strategic Plan. This includes;

- A strategic review of the distribution and transmission Grid requirements, and the 'net' upgrades and 'off-gridding' that can be delivered to facilitate Renewable Energy generation, storage and overall capacity requirements.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

- Strategic Freeports programme and involvement with the new green economy such as CCUS & Blue Hydrogen ecosystems, Rolls Royce SMR Programme, and new offshore wind generation opportunities in the Celtic Sea
- The strategic objectives of the South Wales Industrial Decarbonisation Cluster need to consider specific major emitters such as Tata Steel in more depth through various programmes and research.
- Comprehensive analysis and decarbonisation of nationally strategic assets such as Milford Haven, the largest gas fired power station in Europe
- Opportunities posed by HyNet Phase 3, planned to be operational by 2030, which would see expansion of hydrogen production and extension of the hydrogen pipeline to North East Wales.
- The role of carbon capture, utilisation and storage (CCUS) and the new technologies it involves to enable the capture of carbon dioxide from waste gases
- The future role of hydrogen, both green and blue, and the proposed hydrogen corridors and strategic production sites

Infrastructure Recommendations

R2.1 Work with DNOs to provide clarity on connection times

Welsh Government should work with the DNOs and Development community to better understand the Grid 'net' capacity requirements to meet Net Zero 2050 targets, and understand the impacts of connection delay times, by region, so developers and investors can inform National Grid and the DNO's which areas of limited grid capacity should be prioritised for grid access to enable scheme delivery.

Benefit: Allows Welsh Government to understand areas of strategic importance so funding can unlock renewable energy generating schemes and allows developers to prioritise development in areas that will most quickly be delivered and be operational.

R2.2 Incentivise 'off-grid' development

Welsh Government should work with development partners to consider ways to ensure that significant industrial cluster consumers, new residential, and industrial development of a certain scale that meets viability criteria, will deliver renewable energy generating sources on site as a town planning policy requirement.

Benefit: This will reduce the future demand on the Grid and promote the delivery of sustainable development at sites where it is required. May also provide Longer-term energy security and lower energy unit prices to industrial clusters.

R2.3 Strategic National Infrastructure Plan and Policies

Welsh Government should work with stakeholders to prepare a national Renewable Energy Infrastructure Plan that defines where need, demand, and potential supply is greatest, which will act as a framework for future investment to upgrade the Grid and other networks (pipelines).

As part of the preparation of the Renewable Infrastructure Plan, Welsh Government should work with the DNOs and Development community to better understand grid connection delay times, by region, so developers/investors can prioritise the most nationally significant schemes.

Predetermined areas for overhead cabling, co-location or infrastructure and anticipatory Grid Capacity should also be included to unlock areas of greatest renewable energy generation, storage and distribution potential.

Benefit: This will steer investment to where it is needed, unlock sites, and will facilitate the delivery of renewable energy schemes.

R2.4. Co-Location Prioritisation

As part a combined Planning and Consenting regime, steered by a Renewable Energy Infrastructure Plan, Welsh Government could implement a preferential decision-based system for planning and consents, and Grid capacity access, where schemes of a certain energy generation threshold and storage combined are provided additional weight in decision making, and are subject to a fast-tracked grid access route, which is incentivised for DNOs.

Benefit: This will promote co-location of infrastructure on schemes to ensure generation and storage are delivered as a complementary scheme.

SECTION 3: PLANNING



CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

3 Planning

3.1 Introduction

The Planning System in the UK has evolved over time since its formal inception in 1947, when it was proposed to reshape Britain after the traumas of WWII. While much of the original 1947 Act has been discarded, a lot of the themes remain, such as the need to support the delivery of growth of our towns and cities (in terms of housing and the economy) while also promoting and protecting our environment and green spaces.

In practice, the Welsh government has a 3-tier, top-down planning system. The figure below shows how different tiers of the development plan cumulatively address the issues contained within Planning Policy Wales.

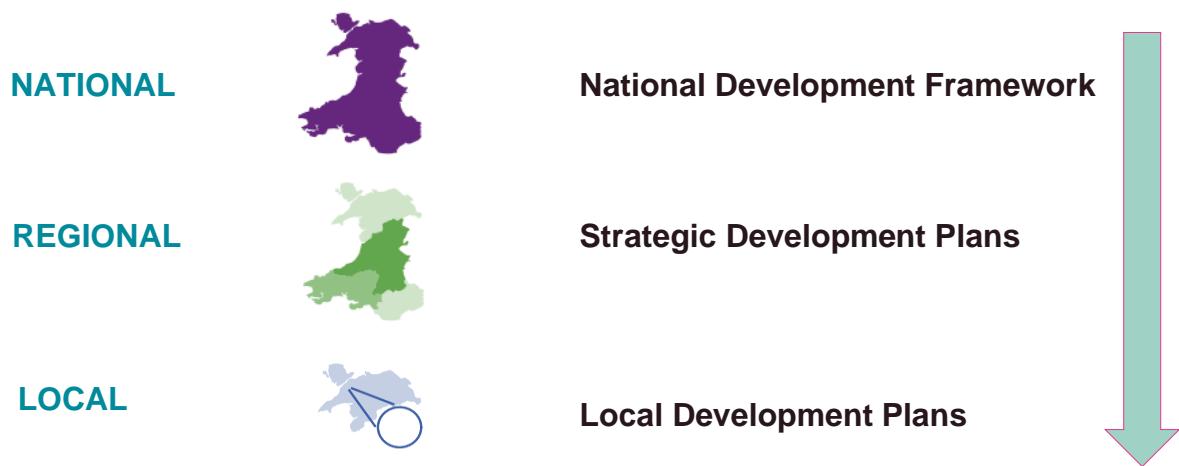


Fig. 18: The Three-Tiered Welsh Planning System

This section considers several aspects of the town planning system which were considered as part of our stakeholder engagement. The table below summarises this.

Headings	Lines of enquiry
1. Procedures	Does the current planning system in Wales facilitate the delivery of renewable energy, supporting infrastructure, or promote co-location? At what stage of the process does/should the public sector seek to get involved?
2. Policy	Is the Planning Policy framework fit for purpose in both promoting and protecting economic, social and environmental opportunities and concerns?
3. Resource	Is there sufficient skills, experience and quantum of human resource within the relevant sectors to support the planning framework?
4. Engagement	Does Welsh Government, its agencies, and the stakeholders adequately guide development? Is enough being done at the right time in the delivery process?

5. Funding	Is there sufficient funding at national, regional, and local level to support and facilitate Welsh Government to achieve its Net Zero in 2050 target? Where could improvements be made and how could these funds be raised?
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Table 4: Planning Lines of enquiry

3.1.1 Context to the Welsh planning system for renewable energy development

Planning Policy Wales (PPW) is the highest order planning policy document which provides strategic direction on planning matters in Wales. Within the policy document is a section on Energy. The document itself provides a positive planning framework and acknowledges the need for significant investment into the energy system in Wales, and the need for a mix of policies that help to uplift the quantum of renewable energy supply, and a reduction on overarching demand.

PPW sets out a framework for Local Authorities, decision makers and applications to secure an appropriate mix of energy provision, which maximises benefits to the Welsh economy and communities whilst minimising potential environmental and social impacts.

In order to grant planning permission for renewable energy generating schemes between 10-350MW, Welsh Government has a system called Developments of National Significance (DNS), which are similar to the Nationally Significant Infrastructure Projects (NSIPs). However, the DNS system only provides planning permission rather than full consents which are wrapped up in Development Consent Orders, which are used in England.

The DNS regime, unlike the NSIP regime, does not establish a separate category of development consent. Instead, an application for DNS is an application for planning permission under Town & Country Planning Act 1990.

Welsh Government are considering a new approach to determining onshore energy generation applications between 10-350MW because the DNS was originally intended to consider schemes up to 50MW, though more consenting powers were devolved on 1 April 2019 to consider up to 350MW. The Welsh Government is also taking the opportunity to combine several existing processes into a single streamlined “one-stop shop” consenting process, known as Infrastructure Consent (IC) regime. The process will also aim to improve application determination speed and success rate with a more transparent process.

To supplement the DNS process, Welsh Government prepared an overarching ‘strategic plan’, Future Wales – The National Plan 2040, to add significant weight for Planning Inspectors determining applications. It is likely that this document will also provide the Planning Framework for the emerging IC regime, though there is an opportunity for Welsh Government to amend the ‘decision-making’ Framework to promote delivery and move away from development control.

3.1.2 Future Wales – The National Plan

Future Wales – The National Plan 2040 seeks to consolidate recent technical and environmental strategy into a single strategic document for addressing key national priorities through the planning system, such as where nationally significant developments like energy, transport, water and waste projects should take place.

With specific regard to on-shore wind, Policies 17 and 18 provide overarching support. There is a spatial dimension to this policy: ten pre-assessed areas (PAAs) identify where there is a presumption in favour of large-scale wind energy development. This additional planning consideration weighs heavily towards the favour of sustainable development providing a Planning Inspector presiding over a DNS application significant weight in the planning balance to recommend the application is positively determined. Local Development Plans are required to be in conformity with Future Wales as the highest tier of the National development plan hierarchy in Wales. This provides strong support for developing wind energy in these areas.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

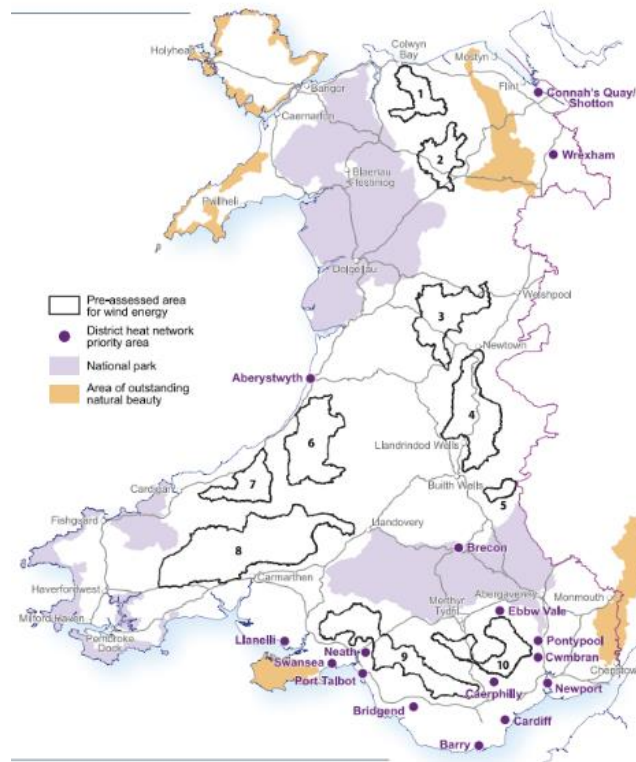


Fig. 19: Pre-assessed areas for wind energy and district heat network priority areas

3.2 Tensions and opportunities from Research and Stakeholder Engagement

From our engagement with both the public and private sector, it was clear that there is a disconnect between what the Welsh Government are doing to facilitate the planning and consenting system and what the developers would want to see done.

The DNS system is not viewed positively due to the slow and political nature of issuing decisions. This may be as a result of under-resourced or inadequately trained personnel. However, it was seen to have many bottlenecks, and anecdotally is seen as a blocker to progress and development of renewable energy generation and energy related infrastructure. Applications do not adequately involve the LPA, they are too readily put on hold by the Planning Inspector and Welsh Government, and decision making is often political and slow.

Additionally, it was considered that the Future Wales document had significant shortcomings and was 'not worth considering' by one individual, however, it was also agreed that the document is a step in the right direction, but more needs to be done to facilitate delivery, as it had some fundamental flaws. The most notable one was that the ten PAAs were only 'acceptable' from a town and country planning perspective and not from a practical delivery perspective – While this may be considered appropriate for a planning policy document, it highlights the disconnect between the town planning system as an arbiter for onshore wind energy provision, if it falls short of facilitating delivery. As a planning policy document, Future Wales is only allowed to relate to planning matters, therefore this is symptomatic of the shortcomings of wider system failure rather than a criticism of the Future Wales document.

As a result, it was suggested during engagement with a major developer that the current town planning framework as a system does not currently dovetail with the aspirations of onshore wind energy developer portfolios. This can be seen through a simple consideration of the PAAs. While the PAAs reduce the town planning policy requirements, it was suggested that in some cases, these were unviable for developers to consider for delivery / viability reasons. This is owing to the 1km clearance distance that is required from the nearest residential property, and that the areas lack a significant access point to the Grid. The perception from engagement with developers and delivery partners is that only '2% of the land identified within the PAAs is currently capable of delivering turbines that meet market commercial viability requirements' (though it is acknowledged this figure may not be accurate it does provide a sentiment of the argument being made in our engagement), while being able to meet the 1km clearance distances. The point made was that without an 'all-encompassing' consenting system that interfaces with other policy areas there is a risk that non-planning matters can denude the PAAs of delivering maximum value to the market or Welsh Government.

This highlights that despite the Future Wales document being prepared and implemented to facilitate on-shore renewable energy developments – through the Planning system - energy developers reported that it has not managed to facilitate delivery (though it is acknowledged it may not have been in place long enough to accurately make this conclusion yet). The reason provided from our engagement was for that Future Wales cannot provide a considerations that sit outside material planning considerations mirroring the main limitation of the DNS system.

Another limitation of the PAAs is that they are located in areas with extremely limited Grid access capacity. This means that even where the PAAs do supplement planning permissions being issued for smaller scale turbines (i.e., ones that can be delivered without the need for 1Km clearance distances), the Plan does not facilitate delivery or foster any anticipatory infrastructure requirements or funding which would help release the PAAs for any meaningful delivery of renewable energy generation. A revised Future Wales should be incorporated with a National Renewable Energy Infrastructure Plan to link the planning system with wider infrastructure and market requirements to facilitate the delivery of renewable energy schemes.

3.2.1 Further Considerations from Stakeholder Engagement

3.2.1.1 The DNS system

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

From the perspective of industry representatives we engaged with, the aim here is for Welsh Government to reduce the burden on limited resources, and reduce the time applications are determined in and increase the number of consents. There is an opportunity to lean into the private sector for upskilling, resourcing, and funding if better overall outcomes can be promised.

3.2.1.2 Future Wales: The National Plan 2040

There needs to be better linkage between planning policy and delivery, which promotes industrial innovation. The PAAs, while a good idea in *planning policy* terms, do not always facilitate innovation of delivery as they do not account for 'non planning matters' such as turbine clearance distances from residential dwellings. Industry representatives believe that the document could be recast in statute to allow Welsh Government to concentrate on *delivery* such as supporting ancillary development. This could in theory provide a framework equally concerned with delivery as much as control. A National Renewable Energy Infrastructure Plan could combine authority under different Acts to facilitate market delivery and be used to focus investment into the Grid where it is needed to unlock renewable energy sites and capacity.

3.2.1.3 Wider Policy Requirements

Wales requires a 'Top-Down' strategic plan relating to transmission lines – for example, a North-South strategic cabling network that could unlock several sites for delivery. Policy should harness and encourage technological advancement and be flexibly written and capable to be future-proofed.

Design issues of overhead cabling is a significant barrier and tension to delivery as they can devalue property, so innovation should be encouraged. A revised Future Plan could be the catalyst to provide Welsh Government with additional strategic powers to deliver renewable energy. This could concentrate on strategic market facilitation and be prepared with full market cooperation and engagement to ensure deliverability is at the heart of the strategy. This should also be used for anticipatory investment by Welsh Government.

Furthermore, planning and delivery policy must not be onerous. It must be simple and applicable to support the market to deliver schemes. Policy must be prepared from the perspective of delivery in Wales and must not be disadvantageous to investors. The current UK political system is one that harbours 'competition' to drive delivery. As such, schemes in Wales will compete with Scotland, where there is significant amount of mature policy that supports the more viable 250m tip turbines, and where there is an overarching ancillary national infrastructure development plan that encourages development.

Renewable energy planning policy (moreover delivery and market facilitation) in Wales needs to undergo a concept-shift; a move away from a restriction and control, and toward a multi-faceted, interlinked system that drives investment and delivery and is there to facilitate the market.

3.2.2 General Permitted Development for small-scale schemes

Our engagement with industry agreed that the preparation of a Welsh General Permitted Renewable Development Order, whereby Wales is zoned for areas appropriate for smaller-scale renewable generation and storage co-location applications, such as for micro-grids would be useful. Zones that are deemed appropriate for renewable energy developments are subject to a 'presumption in favour of development' if they meet certain criteria;

- Type
- Size
- Location
- Mw Output
- Smart Grid Technology

This would help to by-pass certain planning mechanisms at DNS and Local Authority level if developments met pre-requisites.

3.2.3 Resourcing - Expert parachute teams

From our engagement with both the Public and Private Sector, there was consensus that Local Authorities should be able to a) play their part in determining more applications, or b) defer their role in determining applications to a centralised, well-resourced expert team. This should be a choice for each LPA. And these should be determined in accordance with the proposed strategic policy documentation. Where resources are a potential problem, a centralised Welsh Government based specialist team should be 'parachuted' into LPAs to expedite the determination of applications.

3.2.4 Earlier guided Stakeholder and Community Engagement

It is critical to establish support for renewable energy schemes. No one we consulted disagreed that encouraging dialogue with communities is a healthy way of developing support for community infrastructure. However, while a community might support the notion of renewable energy, we were informed that several may not and do not support if they are directly impacted by it and they use the Planning system to block delivery.

A policy solution to this could be that where local communities may be subject to strategic renewable infrastructure interventions, that developers should follow 'best practice guidance' and integrate 'off-grid' energy solutions to those impacted. This could be as part of a s.106 agreement. Community Value Capture / Community Infrastructure Funds should be set up to generate local support for schemes which can generate funds for local social and economic improvements to areas that are currently thought to be overlooked and object to applications.

3.2.5 Funding

Our Engagement with public sector contacts reported a severe lack of funding. In order to properly resource the Planning and Environment Decisions Wales (PEDW) and the LPAs' ability to comply with the DNS system, there could be a national infrastructure levy on new major developments which is pooled and split between LPAs on an annual basis and then ringfenced to support the resourcing of local planning teams, or a centralised expert 'parachute' team. Furthermore, a more appropriate application charging structure for DNS applications could also help to 'top-up' such a funding scheme.

Where LPA's take on responsibility for their part in the consenting process, they should be adequately incentivised to meet target dates, and penalties for non-compliance.

In addition, industry sector partnerships should be fostered, and applicants should be willing to enter into Planning Performance Agreements only where such timeframes can be agreed, where funds can be used to redirect funding towards paying for a suitably qualified and experienced person to 'top-up' LPA's planning resource. Welsh Government should consider preparing a bank of pre-approved Planning Officers able to be 'leased' to LPAs who require a dedicated Officers to provide observations for DNS applications and ensure schemes are not backlogged in the planning system.

Planning Recommendations

From a high-level perspective there are several key themes that could be explored to provide a better system to determine onshore renewable energy applications;

R3.1 Streamline the application process

Simplify the DNS/IC application process for major renewable energy projects and link to a National Renewable Energy Infrastructure Plan with broader legislative powers to delivery. This recommendation suggests a radical overhaul of the process.

Benefit: A fit for purpose approvals process that supports the ambition of Welsh Government policy

R3.2 Provide clear guidance and support

This could include hosting workshops or webinars to help applicants understand the requirements and how to navigate the application process.

Benefit: Applicants have clear expectations of the system and process so can tailor their applications to maximise success, thus reducing time spent by both the applicant and the reviewer

R3.3 Establish a dedicated renewable energy team

A dedicated renewable energy team made up of Planning, Development and specialist technical advisors and practitioners based within Welsh Government should be responsible for managing and processing applications on behalf of LPAs who opt to use it, ensuring that expertise is always available.

Where appropriate, this team should foster collaborative working with private sector companies and organisations to ensure that skills and expertise are available to determine applications. This could include providing funding, training, or bridging the skills gap.

Benefit: Local authorities have access to specialised advice whenever they need it, by pooling resource those with specialist skills remain up to date and capacity is provided as needed to the areas, and investment and resource can be drafted in from the private sector when needed to quicken the process.

R3.4 Develop a fast-track system

The emerging Infrastructure Consenting system should refine mechanisms to fast-track small, medium and large scale projects, and for co-location to increase speed of determination on projects that can be brought forward quickly.

Benefit: Ensures that there is planning resource available to determine applications and stops larger applications clogging up the consenting process for smaller, less contested schemes.

R3.5 Funding

Welsh Government should work with the DNOs and National Grid to pool funds and resources to 'unlock' strategic areas of significant energy generation and storage capacity, rather than for the supply side to demonstrate where the need for extra grid capacity is.

In addition, Welsh Government needs to review and address the determination fee charging schedule for the DNS and emerging IC regime to cover costs of the dedicated Renewable Energy Team and allow Local Planning Authorities to set 'participation' fees for renewable energy generating schemes that they are required to participate in determining (i.e., in preparing a LIR). This should be well in excess of the £7500 currently achieved through the DNS consultation process.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

Benefit: This would enable a Renewable Energy Infrastructure Plan to further guide development with an onus on delivery and would reduce pressure on the planning and consenting system. By incentivising LPAs to deliver the required reports needed, on time, for the Planning consent to be issued, this will ensure LPAs are remunerated appropriately for their input and help them to maintain and invest in resources, and the speed up the consenting process.

SECTION 4: DELIVERY



4 Delivery

4.1 Introduction

The journey to Net Zero by 2050 for Wales will inevitably see challenges and tensions arising from the delivery of renewable energy infrastructure projects. Challenges that have been identified and overcome in the earlier stages of the project may emerge again if they have not been resolved, managed or planned for. For example, frequent and early engagement with the local community should mitigate issues with resistance to an intrusive local project. Although some of the challenges can be anticipated and dealt with earlier, some of issues will arise from the delivery of the project itself.

This section explores the challenges and barriers that there are in the current energy landscape and recommendations for a smoother transition to the future energy landscape we can expect in 2050 and beyond.

Headings	Lines of Enquiry
1. Supply Chain	Are you looking at your global supply chain? Do your raw materials come from unstable areas?
2. Skills Gap	Is there a skills shortage? What skills are needed for delivery of renewable infrastructure projects?
3. Infrastructure Delivery	Is Wales on track to meet the 2030/2050 targets? What are the barriers in achieving this?
4. Needs and Trends	How can policy support streamlining of deployment of renewable infrastructure?

Table 5: Delivery Lines of enquiry

4.2 Tensions and opportunities from Research and Stakeholder Engagement

4.2.1 Supply Chain

The supply chain could struggle to keep up with the rapidly growing pipeline of renewable infrastructure projects and will therefore need a stable supply of key equipment and materials as well as a skilled workforce. The supply chain is crucial in supplying a variety of materials that need to be sourced as part of renewable energy projects.

4.2.1.1 ESG

Businesses are starting to look at their supply chains to assess ESG (Environmental, Social and Governance) and reliability. Stakeholders highlighted this is becoming increasingly important and that the energy sector and stakeholders need to look at this to ensure that there is transparency of the supply chain to ensure that the industries created in Wales to reach Net Zero targets aren't indirectly supporting poor human rights and environmental practices elsewhere in the global supply of materials and parts.

By having supply chain transparency, developers can anticipate capacity needed to carry out works and efficiently use the workforce to deploy the scale of renewable energy projects needed.

"Today's consents are tomorrow's supply chain contracts" **Onshore Wind Developers Group**

It is recognised that consents earlier on in the project process affect the supply chain in the delivery stage. There is a need to invest in supply chain capability and sustainability to keep economic benefits in Wales where possible. It may take time to build the supply chain however more consents will equal more supply chain confidence.

4.2.1.2 Materials

Both the cost and lead time of key components in power and low carbon technologies has increased. This has been supported by conversations with stakeholders that have highlighted issues with the cost inflation of raw materials, especially in the solar industry. The market for materials is increasingly volatile and can be expensive which can lead to an unwillingness to finance/support projects to progress.

A recommendation to Welsh Government would be to encourage companies to grow a manufacturing base in Wales. This will benefit Wales in the long term due to the increase in the demand for renewables globally. WG could encourage manufacturers to open their facilities to produce materials for renewable energy projects.

"For most components [of renewables] you have diversity on supply chains. For example, there is lots of solar capacity in China." **Renewable Energy Provider**

There is a risk that the planned targets for Net Zero in Wales may be delayed and not achieved on time due to rising costs and investors holding back as a result of unstable market conditions.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

A large proportion of renewable energy generation consists of solar PV and wind turbines. Both renewable energy resources have dependencies on global supply chains and raw materials extraction, that effects the availability, sustainability, and cost of the materials. Some of the key issues surrounding the supply chain resilience and resource extraction of these materials include:

- **Dependence on foreign suppliers:** The majority of solar PV and turbine raw materials are imported to the UK, with China and Asia being major suppliers. The British Photovoltaic Association (BPVA) outlines that more than 80% of solar PV modules used in the UK are currently being imported. This dependency on unreliable foreign suppliers can create vulnerabilities in the supply chain due to unforeseen changes in availability and cost of materials.
- **Environmental and social concerns:** The production of some solar PV and turbine raw materials, such as cobalt and lithium, is associated with environmental and social concerns, such as pollution and human rights abuses. This can create reputational risks for companies involved in the production and use of these materials.

These issues highlight the importance of developing more resilient and sustainable supply chains for renewable energy generation. However, this is a global issue and not ubiquitous to the Welsh renewables sector, and so is one which needs to be dealt with, nonetheless through increasing domestic production, developing alternative materials, and promoting responsible sourcing practices.

4.2.2 Skills Gap

National Grid has estimated that around 25,000 people will need to be recruited in Wales across Net Zero energy hubs.

Throughout our engagement sessions, stakeholders mentioned that there is difficulty in accessing high quality workers that are skilled in the “green” sector. The youth organisation we had engaged with also mentioned that there was a lack of knowledge of “green jobs” and how to access them from the younger generations. There is a need to provide education, training and development across the pipeline of projects, from feasibility through to delivery.

There is an opportunity for Wales to provide new, better paid jobs that are long-term. To develop efficient policy and a clear roadmap, education, upskilling and reskilling need to be firmly on the agenda. A disseminated energy system could result in job creation in rural areas. With job creation comes the opportunity for upskilling and reskilling the workforce to support the development and implementation of new energy production.

In June 2022 each Welsh region saw increases in employment, North Wales by 2.4%, Mid and South West by 1.3% and South East Wales by 2.8% and by November 2022, there were 1.45 million people in employment. Currently there are 8,300 people employed in electricity, gas, steam and air conditioning supply across Wales, with a further 81,900 employed in professional, scientific and technical activities and 100,000 employed in construction. Figure 19 shows sectors that could support a transition to a Net Zero Wales, and how many people are currently employed in those sectors across Wales. A move to Net Zero in Wales creates a great opportunity for improving employability across the nation.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

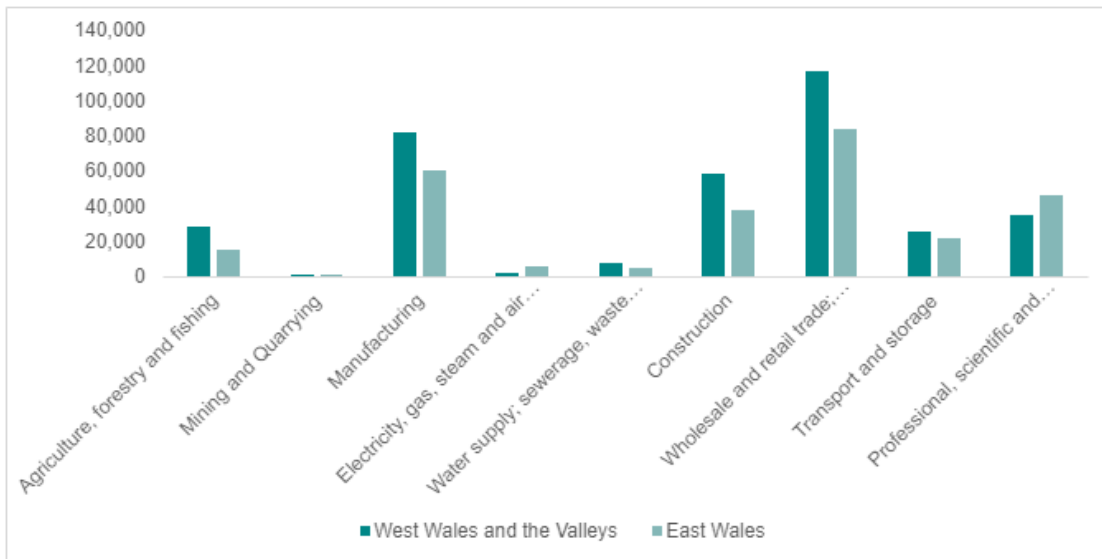


Fig. 20: Sectors that could support a transition to Net Zero

Across current Net Zero policy for Wales, skills and jobs are little mentioned, if briefly included to allude that a transition will lead to skills needs and job creation. In larger policy documents, there is somewhat more mention around investment in skills however beyond that there is no clear direction on skills for a Net Zero Wales. Development of Net Zero skills policy and an action plan could speed up the transition by embedding Net Zero across education and workforce. STEM and technical are in highest demand for delivering Net Zero, and significantly more technical graduates are needed to install and maintain infrastructure.

There is an opportunity for Wales to provide new, better paid jobs that are long-term. To develop efficient policy and a clear roadmap, education, upskilling and reskilling need to be firmly on the agenda.

A clear roadmap has been outlined in Welsh Government’s Stronger, fairer, greener Wales: Net Zero Skills Action Plan published in February 2023. This document sets out Welsh Government’s approach and commitment to Net Zero skills through investing in people, skills and talent. Actions have been highlighted for the short-term, medium-term and long-term starting in Spring 2023. The findings of this report supports finding from engagement with young people in Wales who reported a lack of clarity on what a “green job” is, the skills required and how to acquire a “green job”.

A disseminated energy system could result in job creation in rural areas. With job creation comes the opportunity for upskilling and reskilling the workforce to support the development and implementation of new energy production. Employment by itself will not retain and attract people to work in Wales, there needs to be a focussed approach to place based development.

Wales’s plan for the new renewable energy company presents an opportunity for the Government to generate clean energy with profits going back into the public purse. One of the areas that profits generated could be reinvested back into Wales is into skills and training.

4.2.3 Infrastructure Delivery

Delivery of projects need to be managed to ensure they stay on track to deliver on targets. Stakeholders reported that there is now more pressure to reach their targets set for both 2035 and 2050. Projects must be delivered at a faster pace to stay on target.

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

Supporting infrastructure that facilitates the delivery of Net Zero targets must therefore be considered in tandem with the projects and initiatives themselves. Welsh Government must consider overhead cabling strategies (such as a North-South Line) to unlock vast areas of renewable energy delivery. This refers back to the mantra “I before E”, i.e., *infrastructure* must be in place before Welsh Government can *expand* in renewable energy resilience. This applies at a national strategic level, as well as the local.

The disruption that occurs as a result of renewable energy infrastructure deployment will cause tension in the local communities too. For example, as part of the regional energy strategies, they are looking at the installation of heat pumps across Wales. This will be disruptive to families and people may not be able to afford them especially given the current economic climate. To encourage uptake, there needs to be an incentive for people which could be in the form of a subsidy.

As well as disruption to homes, there will likely be disruption to communities and land. There are existing and public views from some communities that renewable projects may cause disruption especially in smaller villages where the roads are narrower and access routes are limited. The lack of alternative access routes to these smaller villages could result in them being cut off during delivery therefore impacting those that live and work in the area. With wind projects especially, there can be a fear from residents that the structures would be imposing on the landscape. With challenges like these, it is important that the local communities have been engaged with and consulted through all stages of the project, particularly through delivery if these issues are occurring.

4.2.4 Needs and Trends - policy support to streamline deployment

4.2.4.1 Energy Security Strategy and consenting times

Consenting bottlenecks throughout the UK and in Europe have stagnated the deployment of renewables despite interest in increased role of renewables in the UK energy mix. Recent policies however, have shown that these constraints may be eased, enabling deployment to be accelerated.

UK policy shifts towards levelling up and regeneration – These reforms have encouraged onshore developments through easing restrictions and giving more power to local communities.

Smart Export Guarantee (SEG) – Launched in 2020, the SEG requires some electricity suppliers (SEG Licensees) to pay small-scale generators (SEG Generators) for low-carbon electricity which they export back to the National Grid, providing certain criteria are met. This has proven to promote locally owned energy infrastructure by enabling small renewable energy generators to sell any excess electricity they generate back to the grid. This has encouraged wide scale development of locally owned renewable energy infrastructure, such as solar panels on residential rooftops or small wind turbines on farms.

Delivery Recommendations

R4.1 Financial Support & Investment

Welsh Government to make investments and offer financial support to Welsh manufacturers, encouraging them to produce materials for renewable energy projects.

Benefit: Wales has an opportunity to be global leader/suppliers and import costs will be significantly less. This links to a Renewable Energy development plan for Wales.

R4.2 Supply Chain ESG & Social Value

Welsh Government to ensure that it uses all the commercial and contractual levers at its disposal to write KPIs into contracts to monitor supply chain ESG and Social Value.

Benefit: This gives confidence that there is less risk of supply chain disruption and knowledge that the business involved are holding high ethical standards.

This also creates an opportunity to quantify social, economic, and environmental benefits to the community and show progression in social sustainability that is wider than just skills and employment. this can include wider impacts such as improvement in health, cleaner air and the impact on life expectancy.

SECTION 5: IN USE



5 In Use

5.1 Introduction

This section of the report explores the tensions and challenges that may arise during the final part of the project lifecycle where the renewable infrastructure has been built and is in use. By this stage of the renewable energy project, it would be expected that the majority of issues have been resolved. However, as with all projects involving technology, there are likely to be challenges that have only become apparent once the project is in use. For example, there may be challenges around maintenance of the project and longevity of the installed product. Another challenge that may arise is changing standards and the co-location of infrastructure.

Headings	Lines of Enquiry
1. Variable export agreements	Are there any issues between developers and DNOs?
2. Skills	Is there a skills shortage for M&E occupation son renewable energy projects? How can we address the skills gap?
3. Business Continuity	How can businesses ensure stability? What are the dependencies?
4. Public Engagement	How can we better engage with communities in Wales? How can we add value to local communities where energy projects are located?
5. Windfall Tax	What are the benefits of the recent UK Energy Levy?

Table 6: In Use Lines of enquiry

5.2 Tensions and opportunities from Research and Stakeholder Engagement

5.2.1 Variable Export Agreements

During the planning and delivery stages of a project, developers will sometimes enter into a variable export connection agreement with the DNO. Subsequently, this affects the project whilst in use as the energy export capacity can be unpredictable.

Often, the developer will need to enter this agreement as the alternative option is being granted less export capacity or in some cases, none. This can prove challenging to developers as they have most likely built their cost models and projections based on a set figure, however the variable agreement can be unpredictable and result in the developer losing out on energy that could have been sold back to the grid.

The agreement gives the DNOs greater control over the grid to manage demands. There is also the increasing challenge with more energy generation projects looking to connect which the DNO are under pressure to provide connections for. The DNOs are fined if they don't meet the targets that have been set by Ofgem. With the additional pressure from government and clients, this issue will inevitably grow. It is therefore likely that variable export connections will and are becoming increasingly common. Developers are often unaware of this until the project application has gone through.

This reiterates the importance of the recommendations advised throughout this report around prioritisation and strategy for grid connections and plans needed to significantly upgrade this system.

5.2.2 Maintenance – Skills

In the workshop with Welsh Local Authorities, the representatives suggested that one of the challenges for working renewable projects is the lack of training and availability of Mechanical and Engineering (M&E) teams to perform maintenance on renewable energy infrastructure projects. It was suggested that this is as a result of higher education being viewed as the pathway a better salary.

This is where industry and further education are encouraged to collaborate to build the reputation of technical pathways as a solid future career. Investing in and developing apprenticeships in renewable construction (retrofit, heat pumps), manufacturing and energy is the focus of the Institute for Apprenticeships and Technical Education across the UK. These new standards and apprenticeships can only be established by creating a brokerage between industry, education and regulators creating the opportunity to learn what is needed and how it can be addressed. Efforts can be made to develop suitable regulations where there are gaps in order to start developing appropriate training. This could provide a unique opportunity for Wales to be the leaders in Net Zero education.

Across Wales's regional energy strategies future workforce needs were broadly identified to achieve Net Zero . In total, over 62,300 jobs across Wales were identified across electricity and low-carbon energy generation as well as domestic heating services such as heat pump technicians, insulation installers and Solar PV engineers. In order to unlock these opportunities, skills must be understood to be a main driving force to speed up the implementation and adoption of a Net Zero Wales with appropriate policy to support it.

Maintenance for renewable technologies will require a specific set of skills. Welsh Government need to ensure that there is a large enough pool of M&E teams with the correct training to maintain these technologies across Wales. There may be an opportunity to use demand for M&E skills to upskill or retrain Welsh people local to the projects.

As mentioned earlier in the "Delivery" section of the report, the recently published Net Zero Skills Action Plan looks to address upskilling the workforce in all areas attributed to Net Zero , including M&E.

5.2.3 Business continuity

An anticipated challenge with any new renewable infrastructure projects is around business continuity and reviewing continuity plans. This is particularly important for energy companies as there would be a large number of consumers reliant on their services to provide power. Businesses will need to ensure that their services are reliable, consistent and have a plan and resources in place to mitigate the impact should their services fail. The interdependency of systems as a whole should be taken into account when looking at business continuity.

Energy systems can be highly interconnected and interdependent - changes in one part of the system can have ripple effects throughout the entire system. The interdependencies of the energy systems can be grouped into three main categories: physical, operational, and institutional. In general, the interdependencies can be categorised into the three main categories below.

Physical Interdependencies: The physical infrastructure and equipment that make up the energy system. The grid relies on a complex network of power lines, transformers, and other equipment to distribute electricity to consumers. Any disruption in this infrastructure, such as damage from severe weather, can cause power outages and other disruptions to the system. developers need to ensure there is a process in place to recover services. This will become more of a challenge as we are facing the impacts of climate change where we can expect to see an increase in flooding from excessive rainfall and droughts.

Operational Interdependencies: The way that different parts of the energy system interact with each other operationally. The operation of power plants is closely tied to the availability of fuel, such as natural gas or coal with disruptions to this impacting the availability of electricity to consumers.

Institutional interdependencies: The policies, regulations, and governance structures that shape the energy system. The decision to invest in renewable energy technologies can impact the operation of centralised power producers and the overall energy mix of a region or country. Changes in energy policies and regulations can also impact projects as well as the investment decisions of energy companies and the behaviour of energy consumers.

The development of smart energy systems will see an increased reliance on digital technology which although beneficial, will also leave them at risk of digital failures. An example of this is with the smart energy meters. Smart meters are reliant on their own secure data network to send information on supply and demand for each household. A failure in this secure network would impact the data received in monitoring the supply and demand. The systems would need a back-up to ensure data is correct and is not being lost.

The interdependencies above provide important context for the Welsh government and the large increase in the rollout of renewable energy technology and need to be taken into consideration when reviewing continuity plans. These interdependencies of the energy system also highlight the importance of taking a holistic approach to energy planning and management.

To ensure a stable and reliable energy system, it is necessary to consider the physical, operational, and institutional interdependencies and to design policies and practices that take these interdependencies into account.

5.2.4 Public Engagement

Once a project has been delivered, there may be some tensions from the local community similar to tensions identified during the “Delivery” phase. Regular consultation and conversations with the public is key to building a relationship of trust and understanding. There is also a responsibility of people to educate through the new renewable projects and demonstrate how this will benefit the community and contribute towards a greener and more sustainable future.

“There needs to be honest conversation from Welsh Government to Welsh communities on what is required to meet these targets. There needs to be a shift in mindset.” - Large renewable energy provider

From the beginning of the project process, the community should be taken on a journey in order to gain their support. There may be ways that the developers could directly contribute to improvements in the local community using improvement funds.

Stakeholders have recommended that more needs to be done with preparing the people of Wales for Net Zero in 2050 and what this will look like as well as how the shift in power and running of the country will affect them. Regular communication and clear messaging will be key. The Welsh Government have published a draft strategy (Climate Change – A strategy for public engagement and action).

To show added value to the community, developers can be encouraged to invest in social value as part of their projects. Social Value KPIs (key performance indicators) can be embedded into upcoming energy projects and include the following examples –

- Monetary investment to the area
- Community project volunteering days
- Upskilling in green skills
- Apprenticeships created
- School engagement

The Wellbeing of Future Generations Act places a legal responsibility on policy makers in Wales to create holistic solutions to improve the nation’s cultural, social, economic and environmental wellbeing via seven well-being goals, including an ambition for a healthier and environmentally-resilient society and a goal to become a “globally responsible Wales”.

5.2.5 UK Government Energy Profit Levy – Windfall Tax

The Energy Profit Levy, also known as the ‘windfall tax’, was introduced in early 2022 and applies to the profits of oil and gas companies. The levy is being increased to 25% and will remain in place until March 2028, bringing the effective tax rate for the oil and gas sector to 75%.

From January 1st 2023, a tax is being applied to wind, solar and nuclear (low carbon electricity generators) levied at 45%.

The effects of such a tax on the rollout of renewables is complex and depends on various factors. While the tax could generate revenue for supporting renewable energy, it could also increase the cost of energy and potentially reduce investment in renewables.

We recognise that our recommendation may require a devolved level of power and autonomy from the UK government to enable this.

In Use Recommendations

R5.1. Review of export agreement process

Review of the export agreement process between Ofgem, DNOs and developers.

Benefit: Transparency between the DNO and developers would give developers confidence to progress their projects and enable them to accurately forecast their export.

R5.2. Skills & Training

Welsh Government to support and promote training and awareness of key skills on renewable energy projects and delivering on actions outlined in the Net Zero Skills Action plan. There should also be a focus to upskill the workforce local to renewable energy projects.

Welsh Government should work with Educational Establishments and organisations such as Careers Wales, Jobcentre Plus etc to increase “Green Skills” awareness and encourage the younger generations into the industry as well as signposting “green jobs” for people coming out of education or looking for a change in career.

Provide training opportunities to upskill the current workforce and encourage more people into the sector using the example of The East of England Offshore Wind Skills Centre.

Benefit: Upskilling of the local workforce and provision of a long-term occupation in Wales results in lower levels of unemployment. Access to a larger pool of workforce with skills necessary to build and maintain the renewable infrastructure that will be built as a result of the increased demand for power.

R5.3 Business Resilience

Welsh Government to support renewable energy businesses with resilience.

Benefit: Increase in confidence from both businesses and consumers. Businesses will be confident that they can provide a fully operational service and consumers will trust that they can rely on the business for their energy services and provision.

R5.4 Careful consideration of the UK Energy Profit Levy on low carbon generators

The government should carefully consider the design and level of the windfall tax to ‘low carbon generators’ and that the intended benefits of the policy are achieved without negative consequences.

Benefit: If government choose to give this back to the people, it can contribute to energy bills or alternatively can be used to improve other areas of the network.

2050 AND
BEYOND

Introduction

As part of this commission NICW asked Mace to consider horizon scanning beyond 2050 and review the trends, gaps and enablers to delivering renewable energy for future generations. With the pace of change in technology in this field it is difficult to predict exactly what will happen and when. This section of the report aims to highlight what we know now.

Energy Infrastructure Trends

To deliver on the energy transition objectives, there are several trends in energy infrastructure that are becoming more predominant. The UK government have begun to recognise these trends, which it outlines in the Energy White Paper. The Energy White Paper builds on the Ten Point Plan and the National Infrastructure Strategy by providing further clarity on measures and puts in place a strategy for the wider energy system that; transforms energy, supports a green recovery and creates a fair deal for consumers. The paper focuses on several key areas including; empowering consumers, decarbonising the power sector, improving energy efficiency, developing clean hydrogen and supporting innovation – all of which contribute to the understanding of energy and ancillary infrastructure trends.

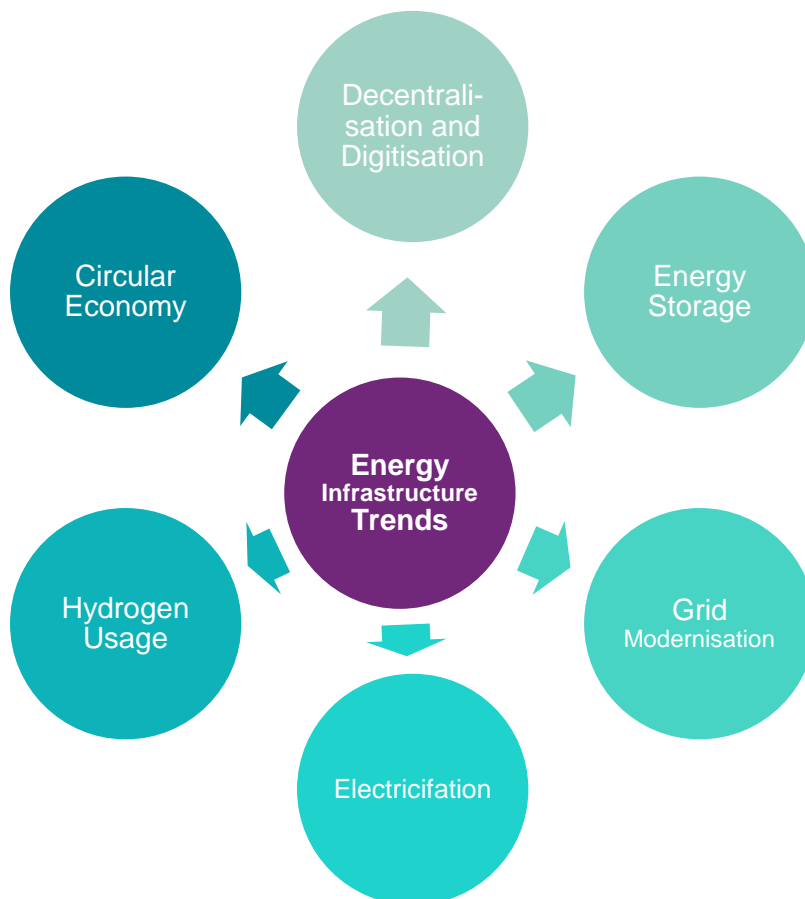


Fig. 21: Energy Infrastructure Trends

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Decentralisation and Digitisation: trend towards decentralisation of energy infrastructure, with more renewable energy projects being developed closer to energy demand centres. This is facilitated by digitisation and the use of advanced monitoring and control systems, which can help to integrate renewable energy into the grid more effectively.

Energy Storage: There is an increasing focus on energy storage technologies, which can help to address the intermittency and variability of renewable energy sources. Energy storage can also help to improve the reliability and resilience of the energy system.

Grid Modernisation: There is a need to modernise the electricity grid to accommodate higher levels of renewable energy and to improve the efficiency and reliability of the energy system. This includes upgrades to transmission and distribution infrastructure, as well as the use of advanced sensors and control systems.

Electrification: There is a trend towards electrification of transportation and heating, which can help to reduce greenhouse gas emissions and improve air quality. This requires the development of charging infrastructure for electric vehicles and the deployment of electric heat pumps for heating.

Hydrogen: There is growing interest in the use of hydrogen as a low-carbon energy carrier, particularly for applications where direct electrification is not feasible, such as heavy industry and long-haul transportation.

Circular Economy: trend towards a circular economy for energy infrastructure, with a focus on recycling and reuse of materials, as well as the development of new business models that prioritise the lifetime value of assets.

Energy White Paper Trends

Further clarity provided by the White Paper show that energy generation is evolving to come from numerous smaller sites, rather than centralised power stations. Tied with this is the increase in the number and variety of energy demand as millions of EV's and heat pumps connect to the system.

The effect this has is an electricity system that is more dynamic, with increased flexibility as to how energy is consumed and generated, allowing for energy supply or demand to be shifted in time or location for efficiency and to lower costs for consumers. An overview of the key changes to the energy system is shown in the figure below.

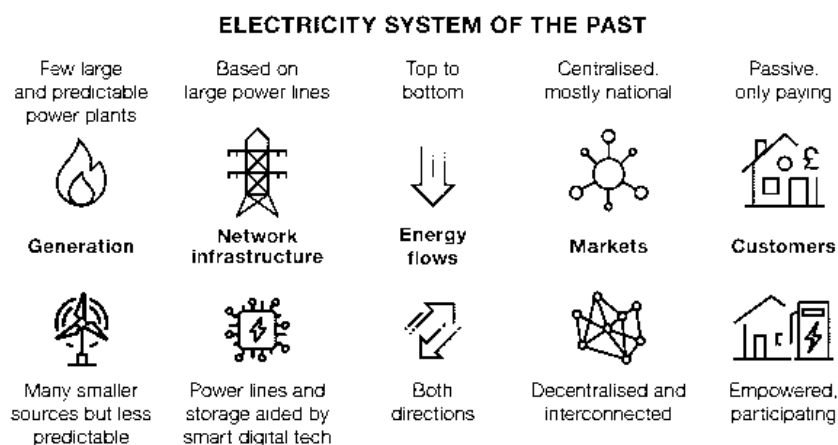


Fig. 22: Electricity Systems of the Past and Future

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Smart Homes and Buildings

The government aims to develop smart energy systems, such as intelligent thermostats, smart lighting, and energy-efficient appliances that can manage supply and demand in real-time, enabling consumers to manage their energy usage more efficiently and cost-effectively. This will require the deployment of new technologies such as smart meters and energy storage systems, as well as policies to support the development of these systems.

Electrification of transportation

The transportation sector is a significant consumer of energy, and as EVs become more affordable and offer longer ranges, we can expect to see a significant shift towards electrification. The government aims to phase out the sale of new petrol and diesel cars and vans by 2030, encouraging the uptake of electric vehicles (EVs) and other low-emission transport options. This will require significant investment in charging infrastructure and upgrades to the grid, as well as policies to support the uptake of EVs.

Evolution of Hydrogen Demand Economy

The Energy Transition Committee, a group of industry leaders and experts, released a report in 2021 outlining the potential timeline for the evolving hydrogen demand economy. The figure below outlines at a high level, how this may develop across various transportation vectors. This provides a useful insight for the future requirements of the hydrogen economy and the long-term vision required by the Welsh government to implement this.

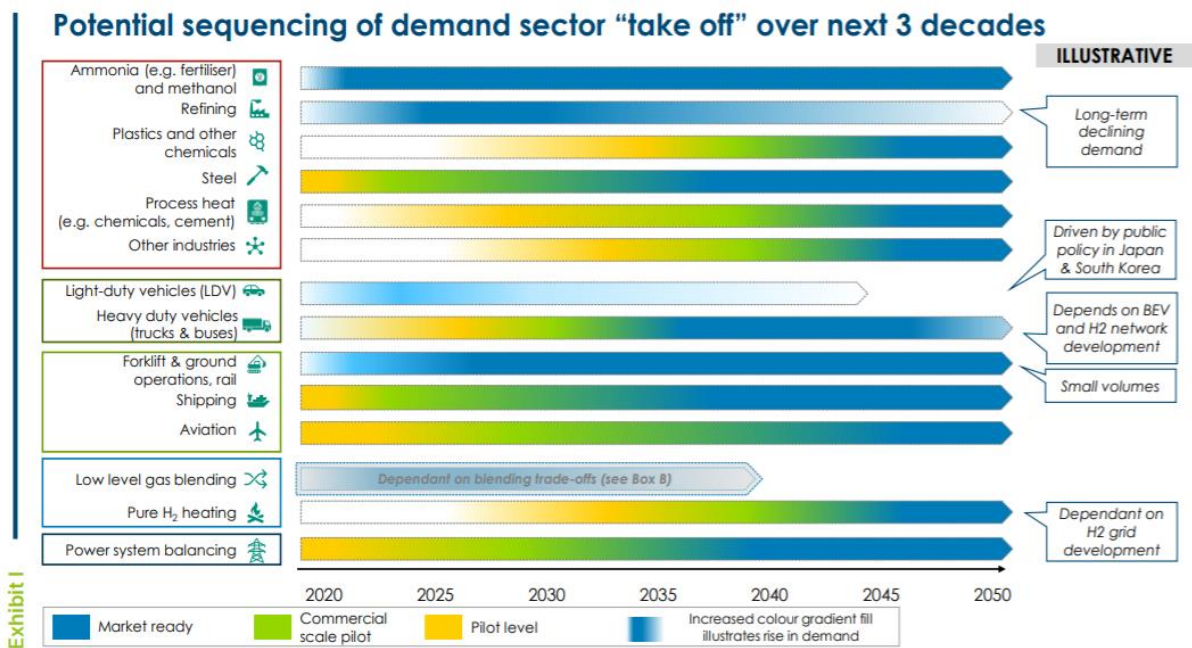


Fig. 23:2 The ETC Hydrogen Demand Sector 'Take offs'

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The report goes on to suggest strategies to simultaneously develop low-cost hydrogen production and demand growth. It indicates that this will be most effective if initially focused on “hydrogen clusters” in which hydrogen production, storage, transport and end use can develop concurrently. The scope overlap of which aligns closely with the Freeports Program. The benefits of this include, but not limited to:

- Provide hydrogen producers with greater certainty on local hydrogen demand and de-risk their business case by diversifying off-takers
- Support the simultaneous development of several different end use applications, rapidly achieving economies of scale in local hydrogen production.
- Accelerate the development of new uses for hydrogen at the same time as decarbonising existing grey hydrogen production
- Minimise the initial need for investments in large-scale long-distance pipeline – with shorter-distance transport infrastructure costs shared between several potential users.
- Promote early development of storage infrastructure, with costs shared between different users.
- Focus policy support on developments that benefit several companies and sectors.

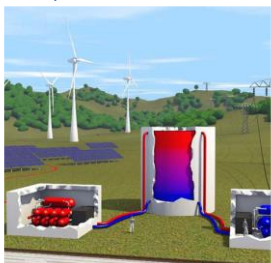
These cluster developments have huge potential throughout Wales and will be dependent on specific comparative advantages of geographies. Including:

- **Ports** – Aggregating future decarbonisation demand across shipping, rail, trucking, and freight
- **Steel Plants** – Such as Tata Steel which are large enough to anchor investment and demand
- **Non-Costal Transport and Logistical Nodes** - multiple demand growth opportunities from aviation, road and warehousing

Understanding the dynamics of the emerging hydrogen ecosystem will aid the Welsh Governments strategic decision making on national infrastructure priorities by incorporating a long-term perspective of future markets across multi-vector technology adoptions.

Potential Future Renewable Energy Generation and Storage Case Studies

By means of inspiration, there are many success stories for both large- and small-scale renewable energy projects emerging globally. These have been outlined below. The Welsh government should look to learn lessons from successful projects and determine the feasibility of applying these within Wales in areas that build on comparative advantages and maximise the benefits to the Welsh Energy Transition, thereby creating a future for Wales where energy is secure, affordable and sustainable.



Siemens Gamesa Electric Thermal Energy Storage Solutions

Siemens Gamesa and Siemens Energy are launching development projects leading to a fully integrated offshore wind-to-hydrogen solution. Siemens Gamesa will adapt its development of the SG14-222 DD offshore wind turbine, while Siemens Energy will develop a new electrolysis product for offshore use.

The aim is to find an innovative solution that fully integrates an electrolyzer into a dedicated platform at the base of an offshore wind turbine as a single synchronized system for offshore hydrogen.

There is a target a total investment of approximately EUR 120 million in the development of this innovative solution.

This decentralized offshore wind-to-hydrogen solution will support the mainstream production of electrolytic hydrogen at scale in three main areas:

1. Enable more and better wind sites to be utilized using island-mode
2. Maximize the amount of wind power that is converted to electrolytic hydrogen by reducing transmission losses
3. Reduce costs further by modularization.



NorthH2 (The Netherlands)

NorthH2 aims to produce up to 4 gigawatts of electrolytic hydrogen by 2030, fulfilling one of the goals set by the Dutch Climate Agreement.

NorthH2 aims to upscale this to more than 10 gigawatts by 2040 where electrolytic hydrogen output, initially produced in Eemshaven and later possibly offshore as well, will total around one million metric tons on an annual basis, cutting carbon emissions by over eight to ten megatons a year.

The consortium, consisting of Gasunie, Groningen Seaports, Shell Nederland, Equinor and RWE, has the support of the Groningen provincial authority.

NorthH2 is also looking at possibilities to convert the generated wind power into hydrogen directly at the wind turbines: electrolysis at sea. As wind turbines are placed further out to sea, hydrogen production close to the source becomes more attractive as the energy generated must be transported to land. This can be done via heavy electricity cables, but it is cheaper and more efficient to transport hydrogen gas molecules.



Brande Hydrogen (Western Denmark)

Siemens Gamesa is developing a hydrogen production plant in Western Denmark. The project couples an electrolyser with an existing onshore 3-MW turbine, with the possibility to run the system in 'island mode', without any connection to the grid.

Brande Hydrogen will provide a clear understanding of the integration of the electrolyser with a variable renewable energy source, and the efficiency of the electrolyser system over time.

Siemens Gamesa was awarded the contract by the Danish government as part of a regulatory energy test zone which exempts Siemens Gamesa from some of the energy regulations in the country, the first of its kind in Europe.

The investment awarded brings technology closer to integrating unprecedented amounts of renewable energy into the energy system.

The Brande Hydrogen project aims to demonstrate that electrolytic hydrogen can be produced without using any power from the grid and serves as an essential test bed for making large-scale, cost-efficient hydrogen production a reality.

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Sihwa Lake Tidal Power Station

Sihwa Lake Tidal Power Station is the world's largest tidal power installation, with a total power output capacity of 254 MW, located in the North of South Korea.



The tidal barrage makes use of a seawall constructed in 1994 for flood mitigation and agricultural purposes. Ten 25.4 MW submerged bulb turbines are driven in an unpumped flood generation scheme; power is generated on tidal inflows only, and the outflow is sluiced away. This slightly unconventional and relatively inefficient approach has been chosen to balance a complex mix of existing land use, water use, conservation, environmental and power generation considerations.

The station's mean operating tidal range is 5.6 m (18 ft), with a spring tidal range of 7.8 m (26 ft). The working basin area was originally intended to be 43 km² (17 sq mi) and has been reduced by land reclamation and freshwater dykes to 30 km² (12 sq mi), likely to be reduced further.

The power station was built in 2011 and started to operate in 2012. The project cost US\$560 million was borne by the South Korean Government.

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Recommendations: Summary Table

In summary, we have found clear appetite from all stakeholders to work together in a collaborative way to reap the benefits of achieving Net Zero 2050 in Wales from an infrastructure perspective. The ambition and aspiration, not only for energy, but across place shaping and creating more prosperous communities is clear to see. In order to realise this ambition, there is a requirement to put in place some structural, policy and regulatory changes to make this happen and we summarise our recommendations below.

Ref.	Recommendations	Benefits
R1.1	<p>Creating a renewable energy infrastructure strategy and roadmap for Wales</p> <p>Create a clear and unambiguous strategy and roadmap around renewable energy and infrastructure across Wales, setting out the different scenarios and energy modalities and how and when this can be achieved. The strategy should include metrics to track the transition in real time and target support to areas where progress is not being made in line with the plan. This roadmap could include a maturity assessment of the four clusters to identify areas to target in the future roadmap.</p> <p>The strategy should communicate clearly to the public what Welsh Government is currently doing to the whole energy system.</p>	<p>Provides confidence that there is a plan for delivering on the Welsh Government ambition with the ability to track progress against the plan</p>
R1.2	<p>System stewardship</p> <p>Welsh Government to set out the system stewardship requirements and governance framework for having a helicopter view across all renewable energy projects, managed by a Programme Board with representatives from Government, the Regional Economic Frameworks, District Network Operators, the Local Area Energy Planning Teams and the private sector who make recommendations and decisions around prioritisation of the schemes that will bring the biggest benefits to Wales. There is an opportunity to consider this through implementation of the Infrastructure Consenting Bill which will be adopted in 2025.</p>	<p>The transition to renewables happens more quickly as there is a clear system approach, prioritisation and governance framework in place.</p>
R1.3	<p>Changing public perceptions</p> <p>Consider what Welsh Government, Local Authorities and other stakeholders can do to proactively change public perceptions by clearly articulating the economic, health, employment and energy benefits of investment in renewable energy at a community, regional and national level through a place economics and/or public health approach.</p>	<p>Raising awareness of the wider benefits of renewable energy and reinvesting in areas which can maximise the socio-economic benefits of investment in renewables, which may also be effective in reducing local objections to schemes</p>

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

	<p>There is an opportunity for Welsh Government to include a financial mechanism in the emerging Infrastructure Consenting process to help communities impacted by renewable energy initiatives to capture a portion of the financial benefit generated by public investment and policy decisions. This could involve the use of land-taxes and impact fees, which allow communities to collect revenue from new development and reinvest it in the local area.</p> <p>Raising awareness of the wider benefits of renewable energy and reinvesting in areas which can maximise the socio-economic benefits of investment in renewables, which may also be effective in reducing local objections to schemes</p>	
R1.4	<p>Potential investment vehicles to support investors and developers, and impact of locational pricing</p> <p>Development of an Investment Commission to work with investors, developers, economists and the Welsh and UK Governments to review the potential investment vehicles both within and out with the devolution agreement. Consider with BEIS the potential impact of locational pricing and whether the benefits will outweigh the risks of implementing a locational pricing scheme.</p>	<p>Attracts more investors/developers to become and remain committed in seeing projects through the full project lifecycle. Welsh Government will have a full understanding of whether locational pricing will incentivise development in the areas where it is most needed.</p>
R1.5	<p>Knowledge transfer</p> <p>Consider what knowledge transfer is available from Scotland, elsewhere in Europe and the rest of the world to make Wales an investable proposition. Consider what can be done to improve the speed of the scheme lifecycle to secure investor confidence. This will inevitably require anticipatory investment in the grid and considering whether Welsh Government wish to influence Ofgem to allow DNOs to make more anticipatory investment in the grid (covered in further detail in section 2)</p>	<p>Increases investor appetite in Wales and allows the lessons learned by other areas to expedite delivery.</p>
R2.1	<p>Work with DNOs to provide clarity on connection times</p> <p>Welsh Government should work with the DNOs and Development community to better understand the Grid 'net' capacity requirements to meet Net Zero 2050 targets, and understand the impacts of connection delay times, by region, so developers/investors can prioritise schemes where Grid capacity or access is limited.</p>	<p>Allows Welsh Government to understand areas of strategic importance so funding can unlock renewable energy generating schemes and allows developers to prioritise development in areas that will most quickly be delivered and be operational.</p>
R2.2	<p>Incentivise 'off-grid' development</p> <p>Welsh Government should work with development partners to consider ways to ensure that significant industrial cluster consumers, new residential, and industrial development of</p>	<p>This will reduce the future demand on the Grid and promote the delivery of sustainable development at sites where it is required. May also</p>

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	a certain scale that meets viability criteria, will deliver renewable energy generating sources on site as a town planning policy requirement.	provide Longer-term energy security and lower energy unit prices to industrial clusters.
R2.3	<p>Strategic National Infrastructure Plan and Policies</p> <p>Welsh Government should work with stakeholders to prepare a national Renewable Energy Infrastructure Plan that defines where need, demand, and potential supply is greatest, which will act as a framework for future investment to upgrade the Grid and other networks (pipelines).</p> <p>As part of the preparation of the Renewable Infrastructure Plan, Welsh Government should work with the DNOs and Development community to better understand grid connection delay times, by region, so developers/investors can prioritise the most nationally significant schemes.</p> <p>Predetermined areas for overhead cabling, co-location or infrastructure and anticipatory Grid Capacity should also be included to unlock areas of greatest renewable energy generation, storage and distribution potential.</p>	<p>This will steer investment to where it is needed, unlock sites, and will facilitate the delivery of renewable energy schemes.</p>
R2.4	<p>Co-Location Prioritisation</p> <p>As part a combined Planning and Consenting regime, steered by a Renewable Energy Infrastructure Plan, Welsh Government could implement a preferential decision-based system for planning and consents, and Grid capacity access, where schemes of a certain energy generation threshold and storage combined are provided additional weight in decision making, and are subject to a fast-tracked grid access route, which is incentivised for DNOs.</p>	<p>This will promote co-location of infrastructure on schemes to ensure generation and storage are delivered as a complementary scheme.</p>
R3.1	<p>Streamline the application process</p> <p>Simplify the DNS/IC application process for major renewable energy projects and link to a National Renewable Energy Infrastructure Plan with broader legislative powers to delivery. This recommendation suggests a more radical overhaul of the process.</p>	<p>A fit for purpose approvals process that supports the ambition of Welsh Government policy</p>
R3.2	<p>Provide clear guidance and support</p> <p>This could include hosting workshops or webinars to help applicants understand the requirements and how to navigate the application process.</p>	<p>Applicants have clear expectations of the system and process so can tailor their applications to maximise success, thus reducing time spent by both the applicant and the reviewer</p>
R3.3	<p>Establish a dedicated renewable energy team</p> <p>A dedicated renewable energy team made up of Planning</p>	<p>Local authorities have access to specialised advice whenever they need it, by pooling resource</p>

CHALLENGES AND TENSIONS IN ACHIEVING NET ZERO 2050 WALES

	<p>and Development practitioners based within Welsh Government should be responsible for managing and processing applications on behalf of LPAs who opt to use it, ensuring that expertise is always available.</p> <p>Where appropriate, this team should foster collaborative working with private sector companies and organisations to ensure that skills and expertise are available to determine applications. This could include providing funding, training, or bridging the skills gap.</p>	<p>those with specialist skills remain up to date and capacity is provided as needed to the areas, and investment and resource can be drafted in from the private sector when needed to quicken the process.</p>
R3.4	<p>Develop a fast-track system</p> <p>The emerging Infrastructure Consenting system should refine mechanisms to fast-track small, medium and large scale projects, and for co-location to increase speed of determination on projects that can be brought forward quickly.</p>	<p>Ensures that there is planning resource available to determine applications and stops larger applications clogging up the consenting process for smaller, less contested schemes.</p>
R3.5	<p>Funding</p> <p>Welsh Government should work with the DNOs and National Grid to pool funds and resources to 'unlock' strategic areas of significant energy generation and storage capacity, rather than for the supply side to demonstrate where the need for extra grid capacity is. In addition, Welsh Government needs to review and address the determination fee charging schedule for the DNS and emerging IC regime to cover costs of the dedicated Renewable Energy Team, and allow Local Planning Authorities to set 'participation' fees for renewable energy generating schemes that they are required to participate in determining (i.e. in preparing a LIR). This should be well in excess of the £7500 currently achieved through the DNS consultation process.</p>	<p>This would enable a Renewable Energy Infrastructure Plan to further guide development with an onus on delivery and would reduce pressure on the planning and consenting system. Incentivise LPAs to deliver the required reports needed, on time, for the Planning consent to be issued, which will ensure LPAs are remunerated appropriately for their input and help them to maintain and invest in resources, and the speed up the consenting process</p>
R4.1	<p>Financial Support & Investment</p> <p>Welsh Government to make investments and offer financial support to Welsh manufacturers, encouraging them to produce materials for renewable energy projects.</p>	<p>Wales has an opportunity to be global leader/suppliers and import costs will be significantly less. This links to a Renewable Energy development plan for Wales.</p>
R4.2	<p>Supply Chain ESG & Social Value</p> <p>Welsh Government to ensure that it uses all the commercial and contractual levers at its disposal to write KPIs into contracts to monitor supply chain ESG and Social Value.</p>	<p>This gives confidence that there is less risk of supply chain disruption and knowledge that the business involved are holding high ethical standards. This also creates an opportunity to quantify social, economic and environmental benefits to the community and show progression in social sustainability that is wider than</p>

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		just skills and employment. this can include wider impacts such as improvement in health, cleaner air and the impact on life expectancy.
R5.1	Review of export agreement process Review of the export agreement process between Ofgem, DNOs and developers.	Transparency between the DNO and developers would give developers confidence to progress their projects and enable to them to accurately forecast their export.
R5.2	Skills & Training Welsh Government to support and promote training and awareness of key skills on renewable energy projects and delivering on actions outlined in the Net Zero Skills Action plan. There should also be a focus to upskill the workforce local to renewable energy projects. Welsh Government should work with Educational Establishments and organisations such as Careers Wales, Jobcentre Plus etc to increase “Green Skills” awareness and encourage the younger generations into the industry as well as signposting “green jobs” for people coming out of education or looking for a change in career. Provide training opportunities to upskill the current workforce and encourage more people into the sector using the example of The East of England Offshore Wind Skills Centre.	Upskilling of the local workforce and provision of a long-term occupation in Wales results in lower levels of unemployment. Access to a larger pool of workforce with skills necessary to build and maintain the renewable infrastructure that will be built as a result of the increased demand for power.
R5.3	Business Resilience Welsh Government to support renewable energy businesses with resilience.	Increase in confidence from both businesses and consumers. Businesses will be confident that they can provide a fully operational service and consumers will trust that they can rely on the business for their energy services and provision.
R5.4	Careful consideration of the UK Energy Profit Levy on low carbon generators The government should carefully consider the design and level of the windfall tax to ‘low carbon generators’ and that the intended benefits of the policy are achieved without negative consequences.	If government choose to give this back to the people, it can contribute to energy bills or alternatively can be used to improve other areas of the network.

Table 7: Summary of Recommendations

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