

Smart strategies for the transition in coal intensive regions

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Roadmap for energy R&I and skills related to energy transition in Wales

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Authors: Rona Michie, European Policies Research Centre (EPRC), University of Strathclyde, United Kingdom
Liliana Fonseca, European Policies Research Centre (EPRC), University of Strathclyde, United Kingdom

Editors: Charalampos Malamatenios, Centre for Renewable Energy Sources and Saving, Greece
Rita Mergner, WIP Renewable Energy, Germany
Rainer Janssen, WIP Renewable Energy, Germany

Contact: Rona Michie
European Policies Research Centre (EPRC), University of Strathclyde, United Kingdom
rona.michie@strath.ac.uk



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1 Introduction

This report details an energy R&I and skills roadmap for Wales. It considers the existing targets and ambitions for the energy landscape of Wales for 2030 and 2050, including existing strategies, policies and plans. The elaboration and implementation of the roadmaps discussed in this report builds on previous work conducted within the TRACER project, namely on Work Package 5 – which focused on the implementation of an Entrepreneurial Discovery Process with stakeholders in Wales, as per the Smart Specialisation framework – and Work Package 6 – on strategies, roadmaps, and decision support tools. Namely, the provisions of:

- the report on projections for energy transition to 2030 & 2050 (TRACER Project Deliverable 6.1);
- the report on the strategic approach to research and innovation (R&I) in the field of energy in Wales (TRACER Project Deliverable 6.2);
- the report on strategies for re-skilling and re-training of the local workforce for energy transition (TRACER Project Deliverable 6.3).

The main aim of these roadmaps is to contribute to the development of an optimal plan for the achievement of the targets and R&I energy strategies set in Wales for energy transition. This implies the identification of measures and actions necessary for the implementation of the plan, as well as of the existing or possible barriers to them and how to overcome them. Ultimately, these roadmaps could provide guidance to policymakers and enhance the legislative framework by proposing pathways for stimulating investments in low-carbon sectors, and incorporating of new energy technologies, re-training schemes and procedures. While this work was carried out in collaboration with the Welsh Government, the objectives and visions represented here are based on several policy documents, independent reports, and scientific research being carried out in the field.

Two main steps have been considered in the presentation of the roadmap for the net zero transition in Wales:

- Prioritisation of the energy technologies (according to TRACER Project Deliverable 6.2) to be considered in the roadmap for the coming decades. This prioritisation works also as a base to assess the needs for corresponding skills retraining of the local workforce (TRACER Project Deliverable 6.3);
- Development of the roadmap by identifying the major axes, measures and actions required within a specified timeframe.

Given that roadmaps have already been developed at the Welsh Government level, this report seeks to expound on existing roadmaps and measures for 2030/2050 and consider alignment and synergies between several pieces of work. Prioritisation of measures has already been proposed to an extent, and therefore the Sections which follow provide a summary of existing work.

The procedure for the determination of an Action Plan to support the Welsh Roadmaps' implementation, as it was conducted, focused on seven major axes: four mainly related to R&I and three in reskilling/retraining aspects. These axes have been formulated based on strategic documents available from the Welsh Government, as well as based on desk-based research and stakeholder consultations under the TRACER project. Measures were proposed and summarised under each of the axes, namely to overcome specific barriers identified. Finally, an action plan for Wales for the coming decades was detailed, as well as reference made to the existing national roadmaps.

Chapter 2 provides an overview of the strategic approach employed for the development of the existing 2030 and 2050 roadmaps for Wales on R&I and skills for the energy transition. These roadmaps are based on policy documents and previous TRACER work, namely under

Work Packages 5 and 6. An analysis of the barriers to the implementation and development of these roadmaps is also presented in this chapter. *Chapter 3* details recommendations for measures to be taken in Wales for the accomplishment of objectives under the R&I energy strategy and for the fulfilment of needs for workforce retraining. Finally, *Chapter 4* summarises an action plan for the accomplishment of the roadmaps, and an overview of future work.

2 Priorities in R&I and workforce development related to energy transition

2.1 Prioritization of R&I activities for the selected energy technologies

As referred to in TRACER Deliverable 6.2, Wales is a strong innovator according to the Regional Innovation Scoreboard 2021. It has demonstrated a consistent increase over time in innovation performance (21.2% increase between 2014-2021). Although Wales spends less on R&D compared to the UK average, there is some evidence that R&D expenditure has also increased across its constituent parts (business, higher education, and government expenditure), with overall R&D expenditure standing at £794m in 2019. University-business interactions are specifically an area of strength, namely in strategic sectors and several technological disciplines related to energy and the environment (Morgan et al., 2017).

The R&I energy landscape and projections for Wales, as discussed in TRACER Deliverables 6.1 and 6.2, are varied and combine different strengths, opportunities, and goals. Wales has a complex and varied geology. Although it has been strongly associated with the coal industry, it has also been the world's leading supplier of slate and copper. Additionally, its combination of a temperate climate and physical geography and geology have given rise to many different types of landscape and biomes rich in biodiversity. Wales thus has a mix of different strengths that can allow it to develop a sustainable energy mix.

Low carbon energy is an area where Wales is well placed to innovate in the exploitation of its natural assets, e.g., in wind and waves. The wider challenge of decarbonisation is approached mainly through renewable energy, and through implementation of the “Well-being of Future Generations (Wales) Act” (Welsh Government, 2015). Regarding energy generation technologies, Welsh Government has established a goal for the country to transition to a low carbon energy system. Targets have been set regarding domestic renewable electricity sources (70% by 2030) and for local ownership of renewable energy capacity (1 GW by 2030, with all projects having local ownership from 2020).

With a declaration of a climate emergency for Wales in 2019 by the Welsh Minister for Environment, Energy and Rural Affairs, a target was also set for net-zero emissions by no later than 2050. Decarbonisation measures are summarised in the policy document ‘Prosperity for All: A Low Carbon Wales’ (Welsh Government 2019a). Alongside this strategy, ‘Prosperity for All: A Climate Conscious Wales’ sets out the climate adaptation programme for Wales over the period 2020-2025 (Welsh Government, 2019b).

Current general energy and environment strategic projections for Wales in the coming decades by the UK Climate Change Committee (2020) (see TRACER Project Deliverable 6.1) foresee:

- a **phase out of fossil fuels**, with a significant reduction for oil demand (-95%) and natural gas (-60%);
- **low-carbon electricity** as a new dominant energy source, with double the output of current levels by 2050;
- development of a **hydrogen economy** from the 2030s onwards;

- UK level growth of **bioenergy and waste** use by 30% to 2050;
- important role of **carbon capture and storage** in the manufacturing and construction sectors, and the production of hydrogen and electricity generation;
- **land use** implications, with shifts from agricultural land to carbon sequestration uses, including tree planting and peatland restoration.

Further to these, specific sectoral R&I priorities and visions have been proposed across several strategic policy documents in both Wales and the UK for the next decades. A compilation of these is included in TRACER Deliverable 6.2 and summarised here. In the **environment sector**, R&I opportunities identified relate to an increasing demand for timber and forest products, with a need to make the supply chain more efficient and to explore new value-added products. Other priorities relate to land regeneration, environmental design, water quality, agricultural impact and climate change, among others. Included here is also the broader relation of people with their surrounding environment, with a need to improve societal understanding and promote behavioural change.

R&I opportunities in the **energy sector** are quite extensive, given that a vision for a sustainable and just energy transition considers a deep restructuring of the energy mix and of both production and demand. As mentioned, there is a goal to substitute fossil fuel power sources in the Welsh energy mix in a sustainable manner. As part of this, SWIC (the South Wales Industrial Cluster) will substitute fossil fuels with low-carbon alternatives and/or installation of CCS at scale. New R&I opportunities would emerge related to high-efficiency electrification, namely in a move to photovoltaics and heat pumps, as well as in the upgrading of the gas and electricity grids and the research of heating alternatives (e.g., mine water, house retrofitting) based on circular economy principles. While no nuclear power stations are currently operating in Wales there may be potential in, for example, investigating linked technologies and in providing support for decommissioning of sites and addressing waste disposal.

Currently, renewable sources with a substantial share in Welsh electricity generation are wind, solar and biomass (TRACER Deliverable 6.2). The energy sources that are expected to be prioritised in the coming decades include:

- **Biomass**, with a modest 30% growth to 2050 at UK level, with R&I activities focused on its utilisation for heat and electricity and the conversion of wastes for commercial application;
- **Hydrogen**, with a proposed pathway for hydrogen development being set out by Welsh Government in a 2021 consultation document (Welsh Government, 2021e). The next stage would be to develop a long-term plan to make hydrogen zero-carbon, after which hydrogen could also play a role in decarbonising the power system;
- **Wind**, both onshore and offshore, with an investigation of cumulative impacts on the environment (e.g., seascape), and on new products, operations, maintenance, and supply chain capabilities. Wales currently has three offshore and six onshore wind farms including the fifth-largest offshore wind farm worldwide in Gwynt y Môr (Sea Wind);
- **Solar**, researching storage opportunities and new uses (e.g., charging electric vehicles). Solar accounted for 12% of all renewable electricity generation in Wales in 2019 and several zones have been identified as priority areas for large-scale solar energy developments in the future (Welsh Government 2019d).
- **Marine and tidal**, taking advantage of Wales' landscape and strategically located ports, and supporting R&I on decarbonisation of fishing activities, aquaculture, and broader supply chain, and making wave and tidal stream technologies more cost-effective and competitive.

Relating to marine and tidal, a major tidal project off Anglesey – the Morlais infrastructure project – has recently been granted £31m of funding in what is likely to be the last large grant from the ERDF programme in Wales. The project demonstrates Welsh Government's interest in finding pathways for marine renewables development and in establishing Wales as the

location of choice for tidal stream developers and the associated supply chain. Wales already has access to expert academic and research facilities on marine renewables, but further investment is required to generate revenue as a sector.

Technology priorities are also set out in “City and Growth Deals across Wales” (Delbridge, Henderson & Morgan, 2017; TRACER Deliverable 6.2). For example, in the Cardiff Capital Region deal, transport engineering and fintech are two of the priority areas; the North Wales Growth Deal highlights, among others, advanced “smart” manufacturing; the Swansea Bay City Deal includes life sciences, well-being and sport; and the Mid Wales Growth Deal prioritises areas such as high value manufacturing and tourism. Low carbon and the environment are focal areas across these deals.

A summary of sustainable priorities for the next decade in Wales in energy and environment can be seen in Figure 1 below:



Figure 1: Priorities in energy and environment in Wales for the next decade

Source: Own elaboration based on Welsh Government strategy documents and plans.

Results from the TRACER research and stakeholder consultation reflect these priorities, and propose a focus on areas of need and opportunity for R&I for the energy transition in Wales:

Table 1: Vision for R&I in the energy transition in Wales based on TRACER stakeholder consultation

	Areas of Need	Areas of Opportunity
Political, regulatory and financial incentive frameworks	- Transition incentives; - Mapping of energy needs and R&D in Wales; - Align Welsh needs with UK and potentially other funding and development sources.	- Public procurement & seed funding; - Local leadership (e.g. city-region deals); - Alignment with Welsh Government economic, energy and related policies and strategies.
Infrastructural and sectoral investments	- Decarbonising heat; - Upgrading and decentralising energy grid; - Improving public transport; - Investment in energy storage; - Reduce energy dependency; - Sustainable and considered green energy shift.	- Retrofitting houses & building design; - Mix of renewables (solar, tidal, wind, nuclear, hydrogen); - ICT, artificial intelligence and high-value manufacturing; - EV infrastructure, methane and CO₂ capture; - Circular economy;

Source: Adapted from TRACER Deliverable 5.3. Report setting out a vision and future-oriented priorities in Wales (2021)

2.2 Prioritization of local workforce reskilling / retraining needs

It has been estimated that around 20% of existing UK jobs (c. 6.3 million workers) will be affected by transition, with around 3 million workers requiring upskilling and another 3 million with skills in high demand. The key sectors identified to be affected are the construction, manufacturing and transport ones (Robins et al, 2019). Within Wales, c.127,000 existing jobs may require upskilling, with c.134,000 existing jobs being in high demand (Robins et al, 2019). At both UK and Wales levels, work has been carried out (and is ongoing) by government on setting out the pathways and targets for economies to achieve net zero, including in terms of employment and skills requirements. There are still some unknowns associated with these processes. As noted by the independent Green Jobs Taskforce report (2021), *“There are still gaps across a variety of sectors. Further clarity of the UK’s decarbonisation pathways, investment timelines and location are required”*.

The UK Government has set an ambition for two million green jobs in the UK by 2030, with employment growth forecasts available for a range of sectors, including offshore wind, energy networks, smart systems, energy efficiency in buildings, electric vehicles, heat networks and circular economy sectors. There will also be significant transformation in the oil and gas sectors (Green Task Force, 2021; see also TRACER Deliverable 6.3). Opportunities in Wales arising from the predicted employment growth are forecast to be concentrated in the tidal, automotive, CCUS and nuclear sectors. Wales-level analyses also forecast new ‘green’ jobs being created in construction, housing, forestry and energy efficiency assessment (contingent on certain specific investment packages or measures being put in place) (Chapman & Kiberd, 2021).

The anticipated skills needs for transition-related growth sectors have been outlined at UK level (Green Jobs Taskforce, 2021). Within Wales, recent work on skills shortages (linked to Wales TUC’s proposed green recovery investment package) has found that the majority of the skills shortages identified are in areas relating to construction, heating, and electrical installation (Chapman & Kiberd, 2021). However, specific reskilling needs will depend on both UK and Welsh Government investment priorities and decarbonisation pathways, and some key decisions are currently still being taken.

Welsh Government’s “Low Carbon Delivery Plan” (Net Zero Wales Carbon Budget 2) outlines the path to decarbonisation for Wales (Welsh Government, 2021b). The plan sets out a “whole-system” approach to net zero carbon transition, and outlines 123 policies and proposals to achieve decarbonisation in Wales. The framework and pathways are supported by specific planned policy interventions set out for each sector. Net Zero Wales refers to the provision of a “competent green skills workforce for Wales”, including new build and retrofit skills for housing (with a focus on upskilling people already engaged in current housing retrofit activity, as well attracting new entrants into the green skills arena). The need for active engagement of business and industry is emphasised, with collaborative approaches between industry and careers advisory services being proposed to help address youth unemployment, showcase new occupations, and support children and young people to acquire the needed skills.

In addition, the current “Welsh Government Programme for Government” outlines a range of objectives related to employment and skills which are relevant to the skills needs of energy transition (Welsh Government, 2021c). Building on these objectives, work is currently underway to develop a **Net Zero Wales Skills Action Plan** by the autumn of 2022. Welsh Government is currently working with stakeholders to:

- build on labour market intelligence from Wales’ four Regional Skills Partnerships, including asking them to highlight skills gaps and shortages and work with the further and higher education sectors in Wales to help inform supply and meet the needs of employers;
- define and achieve acceptance of industry requirements;
- develop National Occupational Standards responding to the low-carbon agenda;

- review qualifications for future skills needs (e.g. research is currently underway on where existing skills in declining or vulnerable sectors have been recognised through Recognition of Prior Learning processes, and how these might lead transition into net zero roles); and
- develop government incentives or legislation/regulation to stimulate skills demand.

At regional level within Wales, the Regional Skills and Employment Plans of the four Regional Skills Partnerships (RSPs) will play a key role in creating route maps and pathways, and identifying regional priorities for reskilling, upskilling and new skills development. This will be carried out in cooperation with relevant UK and Welsh government departments, such as the UK Department for Work and Pensions (DWP). The RSPs are also working with employers in their regions, for example, a construction cluster group is being launched in North Wales. Related, the RSPs have recently jointly commissioned a report bringing together regional level data across a range of sectors, activities and jobs related to green and low carbon activities in Wales. The data relates to current and projected employment, the green jobs market in Wales and further education provision of courses related to the green agenda (Data Cymru, 2022). The new regional energy strategies, along with the new regional economic frameworks being developed, will also play an important role. Skills and employment related to energy transition and decarbonisation are being given high priority in the emerging strategies.

Alongside Welsh Government's work on the net zero skills agenda, other actors in Wales are currently prioritising green skills issues in parallel, including industry stakeholders and further and higher education institutions. For example:

- Among industry stakeholders, the Green Industries Wales Hybrid Green Skills Council was launched in October 2021, with a focus on connecting organisations and individuals to highlight existing green skills-based projects, ventures and schemes across Wales, identifying collective challenges and opportunities and exploring areas for knowledge share and collaboration. In addition, representatives of the renewable energy industry sector are launching a network on skills development to support a Net Zero Wales.
- Among the higher and further education sectors, a range of activity is underway, including mapping of the existing offering, work on the qualifications framework and the piloting of sustainability modules in further education colleges. In terms of specific projects on skills, Swansea University is currently developing the SWITCH-On Skills project, which builds on their 'triangle of training' to develop a demand-led multi-level training academy to support transition to net zero in the industrial, transport, buildings, homes and communities sectors in Wales. SWITCH-On Skills will work in partnership with the higher and further education sectors and industry to provide the skills required for low carbon living, skills pipelines, upskilling and retraining.

Table 2: Vision for labour market, skills & community support in the energy transition in Wales, based on TRACER stakeholder consultation (2021)

	Areas of Need	Areas of Opportunity
Labour market, skills and community support	• Public ownership of energy transition; • Promote local infrastructure and wealth creation; • Access to education and training and skills development; • Creating good quality jobs; • Effective communication of transition benefits for energy literacy; • Identify locational dynamics (e.g. job & residence location); • Address deprivation, especially in former coal mining areas.	• Digitalisation; • Large scale initiatives; • Connecting training providers with businesses and policymakers; • Create and/or promote "centres of excellence" in energy; • Community energy projects; • Co-creation of internationally recognised skills, qualifications and progression frameworks for energy and environmental work.

Source: Adapted from TRACER Deliverable 5.3 (2021)

In summary, a significant amount of activity is currently underway within Wales developing skills-related pathways and roadmaps for the transition to net zero, at national and regional levels and involving a range of stakeholders. This work looks set to address many of the areas of need and opportunity identified during the TRACER research and stakeholder consultation related to the labour market, skills and community support (reproduced in part in Table 2).

2.3 Barriers analysis

Several significant barriers will influence the efforts for the achievement of regional and national targets for 2030 and 2050. As identified in stakeholder consultations and further TRACER work in TRACER Project Deliverable 5.3 (see Tables 1 and 2), these barriers or areas of need can range, generally, from both legislative and regulatory frameworks, physical infrastructure and supply chains, and labour market conditions. These can include, for example, a need to map the energy needs and R&D in Wales and align this with funding sources, to reduce energy dependency and improve the energy grid and public transport network, and to create good quality jobs and improve access to education, training and skills development. These barriers can thus limit the development and success of activities related to R&I on the selected priority energy technologies and for the reskilling and retraining of the existing workforce.

A SWOT analysis carried out in TRACER Deliverable 6.2 in relation to R&I in energy and environment identified the following weaknesses and threats:

Table 3: Potential weaknesses and threats related to the development of R&I in energy and environment in Wales.

Weaknesses:	Threats:
Structural weaknesses including low levels of R&D spend and reliance on EU Structural Funding for R&I activity	Vulnerability to plant closures
R&I system lacks volume and mass	Risk involved – not all projects can succeed, and many projects will risk being outpaced by policy or technological change
Limited R&I capacity among SMEs	Governance system/Welsh Government legislative powers - reserved powers mean that UK government has a role in whether or not important initiatives can proceed (e.g. onshore wind, tidal lagoon)
Existing initiatives are small-scale; need to link up pilot projects with broader vision ('many successful pilots' problem)	Lack of certainty around future R&D funding post-EU Structural Funds
Need for a broader understanding of innovation and mission-orientated innovation to tackle societal challenges	Competitive nature of some potential funding streams (e.g. Horizon Europe) – significant investment of time and resources required to prepare bids, not all of which will be successful
Risk aversion, e.g. perception of early stage funding	Uneven sectoral and social impact of COVID and longer-term structural effects of Brexit; lack of international agreements or avoidance of international declarations.
Lack of strong private sector innovators and high growth firms has resulted in university-led innovation becoming the primary avenue available to absorb EU RTDI funding in Wales	Systemic transitions of sustainability and digitalisation
Uneven success in access to major UK funding sources for innovation	
Innovation support landscape becoming more complex	

Source: Adapted from TRACER Deliverable 6.2 (2022)

The main weaknesses identified relate to the small scale of projects being delivered and the difficulty to scale up, whether due to a fragmented innovation system, low R&I capacity of SMEs or to limited available funding. As previously mentioned, there are still opportunities

available related to the strong existing strategic R&I capacity of the higher education system in energy and environment. In conjunction with businesses' R&I capacity, new developments and achievements could be made in renewable energy sectors (e.g., EV infrastructure, CO₂ capture, building design), as well as other high-value sectors with potential (e.g., ICT, artificial intelligence, manufacturing). Coupled with the development of local leadership and ownership, public procurement and cross-sectoral collaboration at both public and private level can promote innovation and contribute towards achieving net-zero.

Nonetheless, possible threats need to be considered. Aside from the general risk of investing in new technologies and projects, some of the main threats identified in R&I relate to the uncertainty regarding available funding in a post-Brexit context, the vulnerability of certain communities to plant closures, and the reserved powers to the UK government, which may limit Welsh Government action.

Similar barriers can be identified in relation to the reskilling/retraining of the existing workforce. There is a range of uncertainties related to socio-economic, political and technological changes and their impacts on the workforce structure in the country in the coming decades. Namely, in the short-term, both COVID-19 and Brexit will have an impact on both working patterns and overall availability of the workforce, as investments will be limited and/or diverted to certain sectors. The end of access to EU Cohesion policy funding poses a risk for structurally weaker areas, such as the Welsh Valleys, which could lead to poorer quality infrastructure, training and support for business investment and innovation. These former mining areas continue to be marked by the legacy of coal and related industries, with below-average income and wage levels, a prevalence of precarious and low skilled employment, and poorer quality of life overall. In the long-term, demographic shifts and population ageing will greatly determine the workforce structure, while new technologies (e.g., AI and digitalisation) will impact on working patterns and practices.

Overall, potential jobs in decarbonisation-related sectors are contingent on specific investment packages or measures being put in place. However, specific reskilling needs will depend on both UK and Welsh Government investment priorities and decarbonisation pathways, and many key issues are currently being decided (Fawcett & Gunson, 2019; Universities Wales 2019; Welsh Government, 2019c; Welsh Government, 2019e). Nonetheless, recent work has identified that the areas with skills shortages are construction, heating, and electrical installations (Chapman & Kiberd, 2021). These are key areas for decarbonisation that could represent barriers to implementation. In this regard, this work aims to encourage prioritisation of policies and incentives for specific reskilling and retraining.

3 Recommendations for Roadmap Measures

3.1 Major axes needed to accomplish the objectives of the R&I Strategy

The Economic Action Plan, supporting the delivery of the “Prosperity for All” national strategy (Welsh Government, 2017b), has the main aim to foster inclusive growth based on strong foundations, future industries, and productive regions, in order to build economic resilience. In conjunction with the priorities and objectives for R&I in energy and environment identified in TRACER Deliverable 6.2, action should follow four major axes:

1. Welsh Government strategies, plans and statements set out decarbonisation or the transition to a low carbon society as a cross-cutting priority. This axis aims towards mapping existing R&I strengths and needs, and creating the necessary policies, regulations, and incentives to structure and promote the action and collaboration of stakeholders for decarbonisation, entrepreneurship and digitalisation objectives (*Legislation and Incentives*).

2. Supporting the development of domestic value chains and their links with international ones to promote economic growth and R&I in Wales. This includes bridging siloes and bringing together cross-sectoral interests and stakeholders to collaborate in prioritising and development R&I for, e.g., renewable energies, decarbonisation and energy efficiency in Wales. A focus on the R&I strengths of Welsh higher education institutions is a key aspect here (*Connection and Collaboration*).
3. Supporting national competitiveness and inclusive growth in a variety of thematic (e.g., high value manufacturing, renewable energy) and foundational sectors (e.g., tourism, food, retail, healthcare). Innovation can thus be promoted through cross-sectoral collaboration, but also through research and development in key sectors of society (*Foundation and Innovation*).
4. Local ownership is a key element of the transition as it allows for broader public engagement and behavioural change, necessary for long-lasting effective impact. At the same time, it supports social innovation and other initiatives that could be outside of the reach of both government and business. Moreover, it allows for a greater understanding of the impact of the transition towards net zero carbon, increasing the benefits for local communities (*Local Leadership and Ownership*).

The first, second and third axes have the potential to address barriers linked to the small scale of projects being delivered, the fragmentation of the innovation system and, to a certain extent, the overall limited funding. Additionally, collaboration between private and public entities can be fostered here, which can promote overall innovation. The fourth axis addresses potential vulnerabilities of certain communities and develops public engagement and local leadership, which can thus strengthen these areas and improve the quality of life of their population.

3.2 Major axes needed to fulfill the needs for workforce retraining

The action required to fulfil workforce training needs related to the net zero agenda in Wales can be categorised within the following three axes:

1. As relevant policies and strategies are developed by Welsh Government and other bodies and agencies, supporting these to draw on the best available evidence, advice, knowledge and expertise (*Planning*).
2. Bringing together cross-sectoral interests to collaborate in prioritising, progressing and continually adapting skills for renewable energies, decarbonisation and energy efficiency in Wales (*Collaboration and Representation*). This is crucial where there is considerable separate activity underway, to avoid overlaps and encourage synergies.
3. Increasing public engagement in greater understanding of the impact and benefits of the transition towards net zero carbon, with a particular focus on young people and the education system (*Public Engagement*).

The three axes/areas of activity outlined above closely match the remit of a newly formed group set up in 2022 to discuss Wales' skills needs related to energy transition – the *Net Zero Wales: Skills Economies Advisory Forum* (NOW SEAF). NOW SEAF was launched as a direct outcome of discussions held during the December 2021 TRACER Wales stakeholder meeting organised under Work Package 4 (Task 4.2). The discussions identified a need for ongoing collaboration and communication between stakeholders and Welsh Government to help progress the green skills agenda, and the forum was launched to provide this mechanism. The inaugural meeting of the forum was held in January 2022.

The aims of the NOW SEAF include: “to promote and deliver the skills for decarbonisation, sustainable and renewable energies and efficiencies at pace, at competitive whole-life costs and with high assurance”, thus aligning with the three axes identified above, i.e.:

- to promote collaboration of cross-sectoral interests in Wales relating to the net zero skills agenda

- to offer and provide advice and advisory services to Government, agencies and other organisations with an interest in developing the sustainable energies and efficiencies sectors, and
- to advise, promote and contribute to public engagement around the transition to net zero.

As a result, the Forum is well-placed to help take forward the needed actions. The NOW SEAF Forum has met monthly since its inception, with founding members including higher and further education institutes, industry and sectoral representatives, and the Welsh Government. Membership of the forum remains open to representatives of business, industry and sectoral representative organisations, further education institutions, higher education institutions, work-based learning and workforce development organisations, local, regional, national specialist bodies, regional skills partnerships, trades unions and industry professional bodies, as well as community and geographic workforce development bodies.

Collectively, these axes have the potential to help mitigate the impact of barriers identified above related to the reskilling and retraining of the workforce. In particular, a cross-sectoral collaborative approach will help to ensure that training and skills provision works in concert with planned investment, and maximise synergies between the various activities already underway.

3.3 Measures proposed under each one of main axes to overcome the barriers

The set of measures associated with the above defined major axes are described in the following paragraphs of this Section. Aside from these proposed measures per axis, a series of “horizontal measures” could also further support these objectives. These concern, for example, monitoring of process and outcomes of strategies; dissemination of information and results and contribution to the awareness of stakeholders on the roadmaps’ developments and achievements; development of coordination mechanisms between different sectors and stakeholders; identification of emerging trends and needs throughout the implementation of the roadmaps, with appropriate adjustments in measures, objectives and axes.

3.3.1 Measures related to R&I strategy

Several measures have been identified in Welsh Government strategy documents related to R&I and decarbonisation. Namely, decarbonisation measures are summarised in the policy document “Prosperity for All: A Low Carbon Wales” (Welsh Government 2019a). Alongside this strategy, this policy document sets out the climate adaptation programme for Wales over the period 2020-2025 (Welsh Government, 2019b). Moreover, and supporting the delivery of the “Prosperity for All” national strategy (Welsh Government, 2017b), the “Economic Action Plan” seeks to foster inclusive growth and economic resilience based on strong foundations, future industries, and productive regions, with measures focused specifically on the innovation system.

More recently, recommendations have been issued by the Welsh Government on renewable energy (Welsh Government, 2021d). A few examples of these are summarised per axis below:

1. Legislation and Incentives

- Supporting business cases for whole system planning and bringing together of plans across South, Mid and North Wales.
- Review of consenting and supporting evidence and advice, to ensure a timely and proportionate process including:
 - A review of resource needs and options for consenting and advisory processes to keep pace with the growth in renewables;

- Identifying priority marine and terrestrial evidence gaps and mechanisms to fill them, to expedite the application process;
- Reviewing and mapping the process for land-based renewables installations to obtain an environmental permit, with a focus on emerging technologies;
- Identifying options for releasing capacity and redirecting resource to agreed priority areas.
- Set up working group to review options for how procurement can support the acceleration of renewable energy generation in Wales to maximise local economic and social value to include but not limited to:
 - Options for utilising the buying power of the public sector in Wales to support reliable routes to market for community and public sector energy projects, including through long term Power Purchase Agreements (a contractual agreement between energy buyers and sellers, who come together and agree on an amount of energy which is or will be generated by a renewable asset);
 - How advice and support services can better assist community energy developers access market opportunities;
 - How to better engage the community energy sector in the Wales funding Programme;
 - How best practice can be disseminated including feeding into the Welsh Governments best practice group or the Procurement Centre for Excellence if established.
- Set up an expert group to explore ways of drawing down additional investment in renewable energy generation in Wales.
- Scale up local energy plans to create a national energy plan by 2024, mapping out future energy demand and supply for all parts of Wales to identify gaps to enable planning for a system that is flexible and smart - matching local renewable energy generation with energy demand.

2. Connection and Collaboration

- Enhance engagement with Ofgem, Great Britain's energy regulator, to set out Wales' investment needs, with a focus on retaining value within Wales. This includes setting up a joint-working group to look at options for supporting new, flexible grid connections for renewables and energy storage solutions.
- Streamline the process for developing the Celtic Sea renewable energy projects including delegating offshore advisory powers from the Joint Nature Conservation Committee (JNCC) to National Resources Wales (NRW).
- Support greater industry collaboration to maximise supply chain opportunities in Wales.
- Identify marine 'strategic resource areas' with NRW and key stakeholders by 2023 and provide guidance to signpost appropriate and inappropriate areas for development of different renewable energy technologies.

3. Foundation and Innovation

- Smart solutions for transmission and distribution, including the use of AI to maximise the use of the existing network, as well as the development of requirements, funding and opening the market for innovation. Engagement and inputs required from across industry.
- Celtic Sea offshore network design and onshore reinforcements.

- Scoping of a programme of work with industry to maximise the installation of renewables, flexibility, and storage on business and industrial sites. The programme will explore mechanisms to support and de-risk investment.
- Calling on Ofgem to develop a Welsh regulatory derogation to enable energy business model innovation. The objectives of the derogation should include:
 - Accelerate the scale-up of renewable energy in Wales;
 - Enable energy business model innovation;
 - Realise the benefits and wider co-benefits of renewable energy (from a Welsh and energy systems perspective);
 - Unlock energy system value, such as that from demand flexibility customers and consumers peer-to-peer trading and local electricity supply.

4. Local Leadership and Ownership.

- Accelerate actions to reduce energy demand and maximise local ownership retaining economic and social benefits in Wales;
- Scale up resources to support community and local renewable energy in Wales including:
 - From the Welsh Government Energy Service with staff and financial support to ensure coverage for community-owned heat, energy efficiency and transport project development (with continuation for renewable electricity) and support for shared ownership;
 - Action from government to encourage private developers to include options for shared local and community ownership including through tenders issued on public land;
 - Welsh Government funding to build additional capacity in community enterprises to help them start to scale their work and mentor smaller organisations, to create a larger, sustainable sector.

3.3.2 Measures related to workforce retraining

The Draft Terms of Reference of the Net Zero Wales: Skills Economies Advisory Forum (NOW SEAF) envisage a range of planned purposes and activities for the Forum. These will support the promotion and delivery of the skills required for decarbonisation, sustainable and renewable energies and efficiencies in Wales as follows:

1. **Planning.** The Forum will provide advisory services to support the planning and policy and strategy development which is already underway within Welsh Government. This will include:
 - Presenting Welsh Government with evidence and recommendations for sector specific skills solutions for decarbonisation, sustainable and renewable energies and their role within a circular economy.
 - Addressing the full range of skills and research required to achieve the Welsh Government Route Map to Decarbonisation, UK Government Skills for the Green Economy and Net Zero Carbon ambitions.
 - Offering, contracting and/or providing research and evidence to inform the Net-Zero Skills Action plan Welsh Government aim to publish by the Autumn 2022 to capture the following elements:
 - Key sectors within the scope of the Wales Net Zero plan portfolio board categories;
 - Report on the skills needs and evidence base / research published to date;
 - Map critical points / critical sectors over a 5-10 year (possibly longer) period;

- Define and analyse the current skills offering and qualifications: both formal and in-formal including private provision.
- Identify gaps opportunities and emerging potential directions for further analysis.

2. Collaboration & Representation. This will involve:

- Maintaining engagement, sharing and exchanging knowledge within Wales, UK, EU, global contexts and opportunities.
- Prioritising actions required to ensure and assure competitive advantage for Wales, Welsh Industries and workforce in a global market; to lobby for and contribute to their fulfilment.
- Seeking opportunities to represent sectoral interests and engage in developing the sustainable energies and efficiencies sectors using people, research, skills, innovation and development from and in Wales at all points in product, resource and service lifecycles. Representation may include the presentation and promotion of the outputs, achievements and activities of the forum as well as the sharing of best practice at networking, conferences, specialist knowledge groups, government meetings and other opportunities that may arise.

3. Public Engagement. Two potential approaches are envisaged:

- Public engagement activity, to help persuade the wider public on the benefits of moving towards green energy and raising awareness about the steps needed.
- Activity at the early education stage, for example, Marine Energy Wales produce material for schools.

Alongside the measures outlined above, which fall within the remit of NOW SEAF, specific measures related to the work of the Welsh Regional Skills Partnerships have been suggested in the recent Data Cymru report (2022) for the RSPs. The recommendations propose suggestions for RSPs to inform their ongoing strategies on green skills:

- Continue to monitor green jobs postings in the regions.
- Continue to engage with the retrofit agenda and speak to relevant sectors.
- Monitor the developments of SWIC (the South Wales Industrial Cluster) in the medium to long term.
- Respond the new green infrastructure projects.
- Engage with government research and forecasters.
- Engage with sector representatives and education providers on green issues.
- Develop a system to collect data on an ongoing basis.

4 Action Plan for the Roadmap

4.1 Assessment and prioritization of the proposed measures

The Welsh Government has a clear plan for transition to Net Zero. The “Net Zero Wales Carbon Budget 2” describes the planned legislative pathway for the period 2021-2025 and outlines the identified steps for each year (see Table 4). Planned actions which are particularly relevant to TRACER activities, i.e., those which relate to research and innovation, skills, and

interventions addressing the needs of the former coal mining regions of Wales, are highlighted in green.

Table 4: Net Zero Wales Carbon Budget Legislative Pathway

<u>2021</u> ➤ Budget announcement including an updated budget improvement plan ➤ Nature Recovery Action Plan updated in light of COP15 to the Convention on Biological Diversity ➤ Consultation on the next iteration of the Warm Homes programme published ➤ New business recycling regulations introduced ➤ Pilot launched for woodland creation funding offer to replace Rural Development Plan funding ➤ Publish strategic policy position on combustion of fuels for electricity generation ➤ Publish the new National Peatland Programme ➤ First round of public sector emissions reporting completed
<u>2022</u> ➤ Net Zero Wales engagement strategy published ➤ Consultation on developing UK ETS published ➤ Welsh Government Adaptation Plan updated in light of CCC advice ➤ Skills Action Plan published ➤ Innovation Strategy published ➤ Consult on strategy for societal change ➤ Early outputs from integrated electricity network planning ➤ Roads review report due ➤ Launch a year-long pilot allowing businesses to compare their performance within the office sector to operationalise and test a new scheme ➤ Timber strategy for Wales developed and published ➤ Welsh Government's plan for net zero by 2030 published ➤ All new cars and light goods fleet vehicles procured across NHS Wales after April 2022 will be battery-electric wherever practically possible ➤ The first phase of a new regime for pollution control in industry using Best Available Techniques (BAT) will be implemented ➤ New business recycling regulations introduced ➤ £800m invested in brand new rolling stock with more than half the trains assembled in Wales
<u>2023</u> ➤ Legislation implemented for new decarbonisation readiness requirements for power plant. ➤ Heat strategy for Wales published ➤ Default speed limit change from 30mph to 20mph in built up areas comes into force. ➤ A PAS 2035 survey (assessment for energy retrofit measures) and a clear plan for individual social homes will be required. ➤ The Warm Homes scheme will have supported at least a further 12,000 homes since 2021, with energy efficiency measures, with thousands more supported through the Optimised Retrofit Programme. ➤ A range of indicators and performance measures is developed to make sure our direct financial support assists projects which help Wales become a net zero economy. ➤ All public sector organisations have published plans to achieve collective net zero by 2030. ➤ Strategic Resource Areas for marine renewable energy will have been identified. ➤ A 4.5 kilometre test track expected to be constructed as part of the £150m Global Centre of Rail Excellence, based at Onllwyn.
<u>2024</u> ➤ All areas of Wales to have a detailed local energy plan to enable a cleaner future. ➤ At least one renewable hydrogen production site of 10+MW established. ➤ Tidal lagoon challenge developed. ➤ Extended producer responsibility for packaging introduced. ➤ UK ETS net zero cap implemented (at the latest). ➤ Transition to Sustainable Farming Scheme started. ➤ The SWIC (South Wales Industrial Cluster) deployment project will complete.

➤ Transformation of Core Valleys Lines completed, including electrification and enabling four trains per hour. ➤ A brand-new rail station opened in St Clears.
2025/2026 ➤ Single use plastics banned. ➤ All new City and Growth Deals will have carbon reduction at their core and will contain carbon reduction outputs as key metrics for monitoring and evaluation. ➤ At least six flexible working sites in the Valleys financially supported and delivered. ➤ A network of electric vehicle charging points on the strategic trunk road network every 20 miles across Wales to facilitate easier long-distance travel delivered. ➤ Part L buildings regulations changed, raising the bar to require new homes to produce a minimum of 75% less CO₂ emissions than ones built to current requirements. ➤ 20,000 new low carbon social homes built. ➤ Food waste halved and recycling rate increased to at least 70%. ➤ No biodegradable materials sent to landfill. ➤ More than 3,000 hectares of peatland restored. ➤ National Forest created, with 30 new woodlands and 100 Tiny Forests. ➤ The whole Traws Cymru bus fleet will be zero tailpipe emission by 2026. ➤ The Global Centre for Rail Excellence will open its second, longer high-speed test track, bringing the site into full operation.

Source: Welsh Government (2021b)

The legislative pathway outlined in the “Net Zero Wales Carbon Budget 2” represents a *de facto* roadmap for Wales’ transition to net zero, outlining the required steps and committing to these steps. Carbon budgets 3 and 4 will cover the period up to 2035. Alongside the legislative pathway outlined in the Carbon Budget, several route maps have already been developed in Wales relating to decarbonisation, e.g. for decarbonising the Welsh public sector and for decarbonising housing (see Figure 2 and Figure 4 respectively).

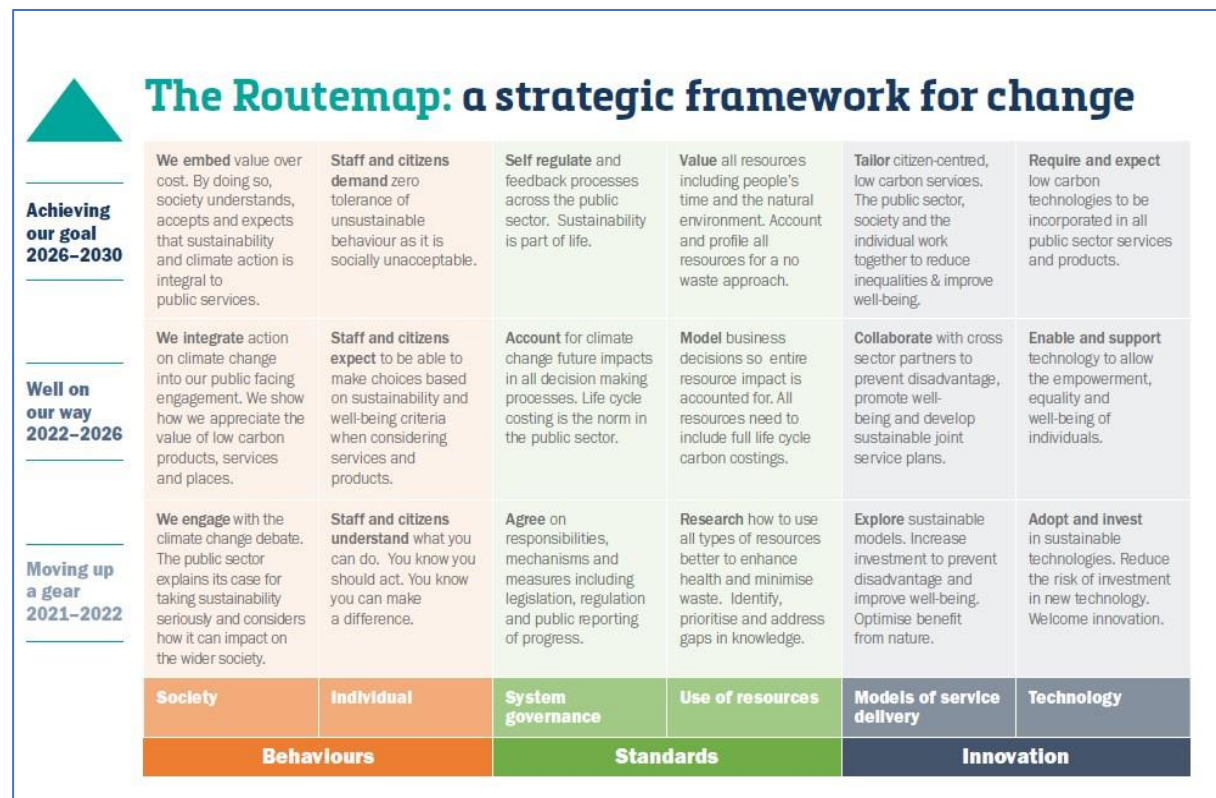


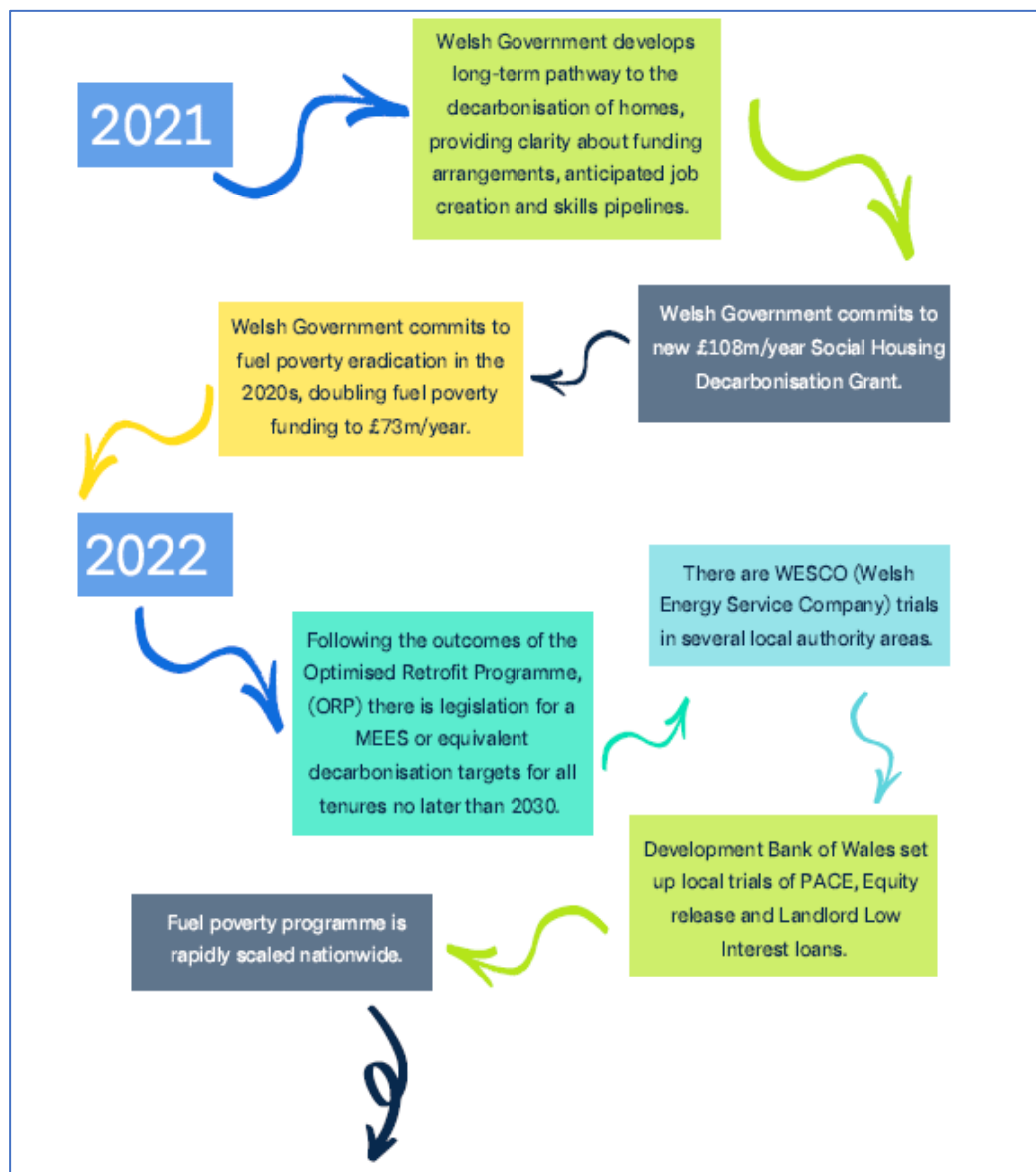
Figure 2: Route map for decarbonising the Welsh public sector

Source: Welsh Government (2021a)

In terms of prioritization of the measures needed to reach net zero, the legislative pathway already outlines a clear step-by-step process for Wales. Key priorities identified in the TRACER stakeholder consultation included the need for:

- a clearer path to help planning for the future, including for jobs and skills;
- high quality jobs and fair work practices;
- synergies between action in innovation policy, education and skills and energy policy;
- prioritisation of connectivity to create employment in areas where well paid jobs are less readily available; and
- provision of training for more deprived communities, especially those previously reliant on the coal industry.

These priorities remain relevant as the net zero legislative pathway progresses in Wales, and as relevant government policies and strategies emerge (such as the new “Innovation Strategy” and “Skills Action Plan”, both expected later in 2022). In the meantime, activities such as *cross-sectoral collaboration and engagement* will continue to be important. Collaboration and communication will help avoid overlaps between the extensive activity and evidence-gathering underway, and will help build momentum, as well as consensus and a shared view of the way forward.



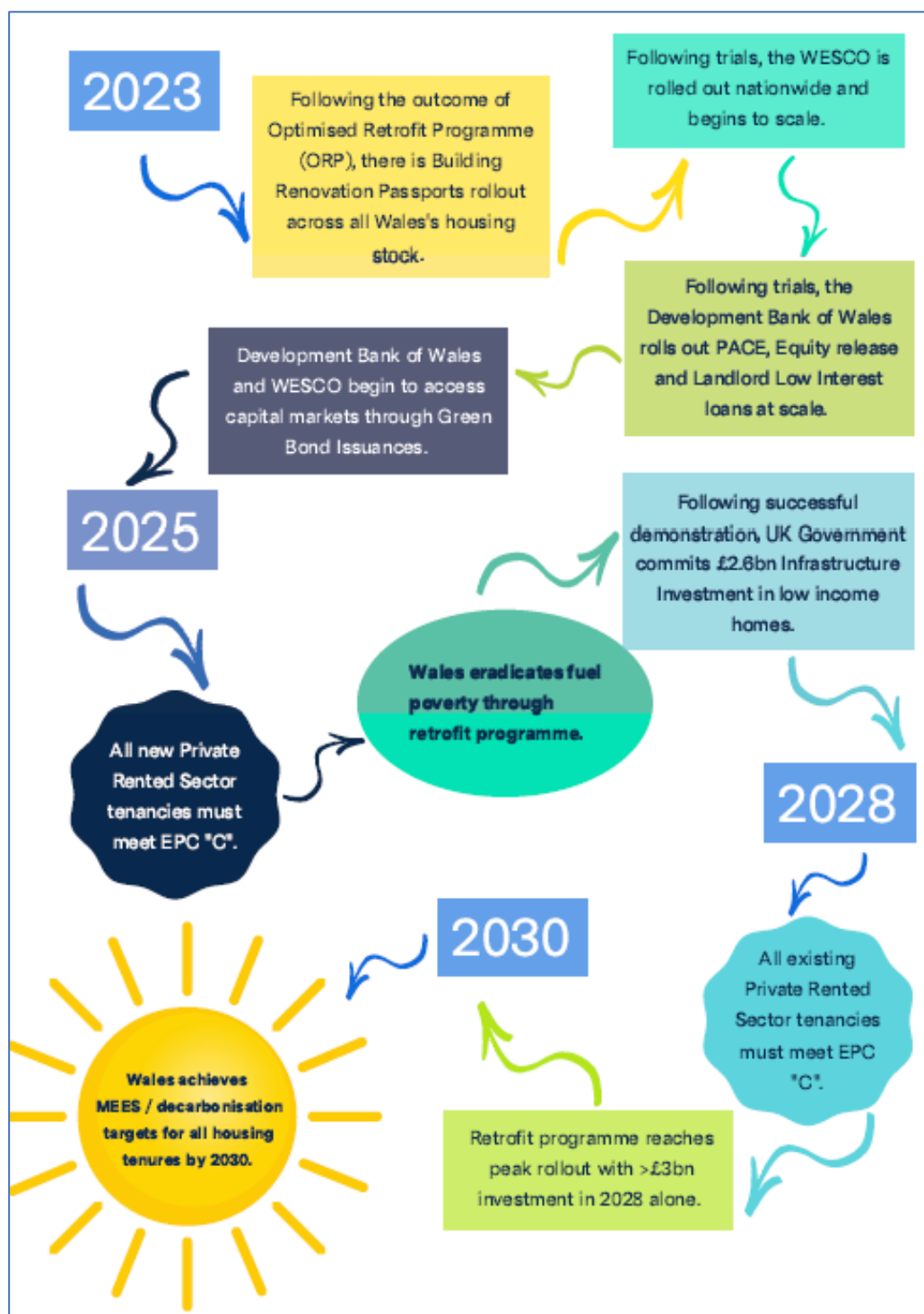


Figure 4: Decarbonisation of Housing Roadmap to 2030

Source: Brown et al. (2021)

4.2 Specification of the set of actions required to implement the Roadmap

As described above in Section 3.1, the legislative pathway outlined in the “Net Zero Wales Carbon Budget 2” represents a *de facto* roadmap for Wales’ transition to net zero. The legislative pathway outlines the required steps and commits Welsh Government to these steps. Further plans will be published in due course, with the next two budgets covering the period up to 2035.

The main **actions** planned by Welsh Government to implement the roadmap are summarised in Table 5 below, with a particular focus on those actions which are most relevant to the scope of the TRACER project. This highlights the steps that must be achieved to stay on track, organised by broad theme, alongside the planned time frames.

The TRACER project focuses on the themes of R&I and skills related to energy transition, and within Wales key steps are planned during the course of 2022 which will represent a major step forward in terms of planning the transition to net zero. Namely, Welsh Government is currently working on a new *Innovation Strategy* and a new *Net Zero Skills Action Plan*, both due to be published later this year. This work involves extensive evidence-gathering and engagement with stakeholders. At the same time, stakeholders such as industry and the higher and further education sectors, as well as local government and bodies such as the Regional Skills Partnerships, are undertaking their own activities. As this work progresses, it is important that there is ongoing *coordination and cross-sectoral engagement and collaboration*. For skills, the NOW SEAF group formed as an outcome of the TRACER project has important potential to provide a forum for this joint task.

Table 5: Summary of main legislative actions, themes and timeline for the transition to Net Zero in Wales over 2021-26

	2021	2022	2023	2024	2025/6
Main theme	Nature, emissions & recycling	R&I, skills & social engagement	Preparation, indicators & performance	Industrial transformation & local leadership	Nature, regional leadership & social transformation
	National Peatland Programme	Net Zero Wales engagement strategy	Heat strategy	Development of tidal lagoon challenge	Single use plastics banned
	Public sector emissions reporting	Skills Action plan	Indicators and performance measures developed for net zero	Established local energy plans in all areas of Wales	City and Growth Deals will have carbon reduction at their core
	Updated budget improvement plan	Innovation Strategy	Public sector organisations with published net zero by 2030 plans	UK ETS net zero cap implemented	Six flexible working sites in the Valleys
	Nature Recovery Action plan	Consultation on strategy for social change	Identified Strategic Resources Areas	Sustainable Farming Scheme	National Forest created
	Policy position on fuels' combustion for electricity generation	Net Zero by 2030 plan	Decarbonisation readiness requirements for power plants	Completed SWIC (South Wales Industrial Cluster) project	> 3,000 hectares of peatland restored
	New business recycling regulations	New regime for pollution control in industry		Transformation of Core Valleys Line completed	20,000 new low carbon social homes

Source: Welsh Government (2021b)

Welsh Government is leading on this pathway within Wales, but recognises that the involvement of other organisations and stakeholders will be key, in a 'Team Wales' approach. This is recognised in "Working Together to Reach Net Zero, All Wales Plan 2021-25", which showcases pledges for action from businesses, public sector bodies, communities, schools and individuals as well as case studies on how partners are working towards net zero (Welsh Government, 2022). For the themes of R&I and skills, close and ongoing involvement of the higher and further (and primary) education sectors will be crucial, along with the Regional Skills Partnerships, regional initiatives and local government, other public sector bodies, industry bodies and employers, and the third sector.

Future sources of funding for energy R&I and skills will continue to include the UK and Welsh Governments. The importance of a coordinated approach will become increasingly crucial during implementation of new sources of domestic funding (post-EU Structural Funds), as funds such as the new Levelling Up Fund, Community Renewal Fund and Shared Prosperity Fund target the local level. This highlights the usefulness of an overview of ongoing initiatives and projects in Wales which address net zero transition. In addition, funding through UK agencies and European funding through programmes such as Horizon Europe will potentially be useful to help pursue strategic collaborative projects.

References

BROWN, D., JACCARINI, C., KUMAR, C., MADGE, C., POWELL, E. (2021) Financing Wales' Housing Decarbonisation, New Economics Foundations.

CHAPMAN, A. & KIBERD, E. (2021) Skills Through Crisis. Upskilling and (Re)Training for a Green Recovery in Wales, New Economics Foundation and Future Generations Commissioner for Wales <https://www.futuregenerations.wales/wp-content/uploads/2021/05/20-05-2021-ENG-NEF-Skills-report.pdf>

DATA CYMRU (2022) The labour market of tomorrow – jobs, skills and the transition to a green economy, Report on behalf of the Regional Skills Partnerships in Wales.

DELBRIDGE, R., HENDERSON, D. & MORGAN, K. (2021) Scoping the future of Innovation Policy in Wales, Cardiff University, <https://businesswales.gov.wales/innovation/sites/innovation/files/documents/MASTER%20COPY%20-%20Scoping%20innovation%20policy%20in%20Wales%20final%20report%2019th%20May%20final.pdf>

FAWCETT, J. & GUNSON, R. (2019) A 21st Century Skills System for Wales. Challenges and Opportunities. Institute for Public Policy Research Scotland, Edinburgh, July 2019: <https://www.ippr.org/files/2019-07/a-21st-century-skills-system-for-wales-july2019.pdf>

GREEN JOBS TASKFORCE (2021) Report to Government, Industry and the Skills Sector, <https://www.gov.uk/government/publications/green-jobs-taskforce-report>

MORGAN, K., HEALY, A., HUGGINS, R. & THOMAS, M. (2017) Growing the value of university-business interactions in Wales. National Centre for Universities and Business.

NET ZERO WALES: SKILLS ECONOMIES ADVISORY FORUM (NOW SEAF) (2022) Draft Terms of Reference.

ROBINS, N., GOULDSON, A., IRWIN, W. & SUDMANT, A. (2019) Investing in a just transition in the UK. How investors can integrate social impact and place-based financing into climate strategies. London School of Economics. <https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/01/Investing-in-a-just-transition-in-the-UK.pdf>

TRACER PROJECT DELIVERABLE R. 6.3 (2022) Report on the needs for workforce retraining in Wales. H2020 TRACER project. TRACER Project, No: 836819.

TRACER PROJECT DELIVERABLE R. 6.2 (2022) A strategic approach to research & innovation in the field of energy in Wales. H2020 TRACER project. TRACER Project, No: 836819.

TRACER PROJECT DELIVERABLE 6.1 (2021) Projections for the transition to 2030/2050 in the target regions. TRACER Project, No: 836819. https://tracer-h2020.eu/wp-content/uploads/2021/06/TRACER-D61_Energy-Projections.pdf

TRACER PROJECT DELIVERABLE 5.3 (2021) Report setting out a vision and future-oriented priorities in Wales. TRACER Project, No: 836819.

UKCCC (2020) ADVICE REPORT: A Path To Net Zero Wales. London: UK Committee on Climate Change, December 2020: <https://www.theccc.org.uk/publication/the-path-to-net-zero-and-progress-reducing-emissions-in-wales/>

UNIVERSITIES WALES (2019) Solving Future Skills Challenges in Wales: <https://uniswales.ac.uk/media/solving-future-skills-challenges-in-wales.pdf>

WELSH GOVERNMENT (2015) Well-being of Future Generations (Wales) Act 2015, <https://www.futuregenerations.wales/about-us/future-generations-act/>

WELSH GOVERNMENT (2018) Employability Plan. <https://gov.wales/sites/default/files/publications/2019-03/employability-plan-2.pdf>

WELSH GOVERNMENT (2019a) Prosperity for All: A Low Carbon Wales. Issue March 2019: https://gov.wales/sites/default/files/publications/2019-06/low-carbon-delivery-plan_1.pdf

WELSH GOVERNMENT (2019b) Prosperity for All: A Climate Conscious Wales. https://gov.wales/sites/default/files/publications/2019-11/prosperity-for-all-a-climate-conscious-wales_0.pdf

WELSH GOVERNMENT (2019c) Digital 2030: A strategic framework for post-16 digital learning in Wales. Cardiff.

WELSH GOVERNMENT (2019d) Priority Areas for Solar and Wind Energy. Executive summary stage 1 and 2. Ove Arup & Partners Ltd, Bristol, United Kingdom. Issue 12 July 2019.

WELSH GOVERNMENT (2019e) Wales 4.0: Delivering Economic Transformation for a Better Future of Work. Cardiff; <https://gov.wales/sites/default/files/publications/2019-09/delivering-economic-transformation-for-a-better-future-of-work.pdf>

WELSH GOVERNMENT (2021a) Net Zero Carbon Status by 2030. A route map for decarbonisation across the Welsh public sector. <https://gov.wales/sites/default/files/publications/2021-07/a-route-map-for-decarbonisation-across-the-welsh-public-sector.pdf>

WELSH GOVERNMENT (2021b) Net Zero Wales Carbon Budget 2 (2021-25). Wales' commitment to tackling climate change. OGL. Digital ISBN 978-1-80391-158-8. <https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-carbon-budget-2-2021-25.pdf>

WELSH GOVERNMENT (2021c) Programme for Government – Update. December 2021. <https://gov.wales/sites/default/files/publications/2022-01/programme-for-government-update-december-2021.pdf>

WELSH GOVERNMENT (2021d) Renewable energy deep dive: recommendations. Outcome of the exercise to identify opportunities to significantly scale up renewable energy in Wales. <https://gov.wales/renewable-energy-deep-dive-recommendations-html>

WELSH GOVERNMENT (2021e) Hydrogen in Wales. A pathway and next steps for developing the hydrogen energy sector in Wales. Welsh Government Consultation Document. 18 January 2021. <https://gov.wales/sites/default/files/consultations/2021-01/hydrogen-in-wales-consultation.pdf>

WELSH GOVERNMENT (2022) Working Together to Reach Net Zero. All Wales Plan 2021-25. April 2022. <https://gov.wales/sites/default/files/publications/2022-04/working-together-to-reach-net-zero-all-wales-plan-april-22-update.pdf>