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Eco-equalities for a Just Transition to Net Zero: Applying an equality mainstreaming framework

MacBride-Stewart Sara ^{a,*}, Parken Alison ^b, Ashworth Rachel ^c, Minto Rachel ^d^a School of Social Sciences, Cardiff, Wales, UK^b Cardiff Business School (Honorary), Cardiff, Wales, UK^c Cardiff Business School, Cardiff, Wales, UK^d Law and Politics, Cardiff, Wales, UK

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ABSTRACT

There were hopes that Net Zero policies would provide solutions that address social inequalities, including improved access to fair work and new 'green' jobs. This has proved problematic due to a lack of clarity on key beneficiaries and the type and quality of employment required, resulting in calls for Net Zero policies to focus more explicitly on social inequalities. In response, this paper considers whether theoretical debates in the equality and Net Zero literatures can be 'bridged' to develop better integrated equality measures to underpin a Just Transition and assesses which systemic challenges we need to overcome so policymakers can deliver those measures. Analysis of exploratory research findings from an action research study of equality mainstreaming in Net Zero policy development – which engaged with equality experts, as well as other stakeholders invested in a green transition in Wales – identifies the potential to promote a more wide-ranging ecological ethos, scope to redefine Net Zero employment, plus a need for wholesale environmental upskilling. The paper advances the concept of eco-equalities as a key construct which has the potential to bridge equalities and Net Zero literatures and concludes by identifying theoretical and policy implications.

1. Introduction

It is claimed that the transition to Net Zero has the potential to develop and implement solutions that address social inequalities, including improved access to fair work and new 'green' jobs [1,2]. Consequently, there has been a proliferation of energy policy research that documents the widespread effort to develop the operational solutions and skilled capacity that will help to support and extend the labour market [3]. Much of this work centres on the 2015 UN Paris Agreement and its emphasis on addressing social inequalities as an integral approach to addressing climate change. However, as Allison et al. [3] notes, problems continue to persist, including a lack of clarity on key beneficiaries and the type and quality of employment required. Further research is needed so we can better understand and assess whether well-intentioned interventions are likely to prove to be effective or run the risk of reproducing and exacerbating existing inequalities [4,5].

Further, scholars have identified energy sector strategies that are deemed appropriate in the context of Net Zero but fall short in equality

terms [6]. For example, many governments are promoting the need for energy security but this manifests itself in several contradictions related to social life [7]. For example, Newell [8] suggests that energy security and energy affordability are often promoted as universal co-benefits, framed mostly in economic terms. But the emphasis is on the economic and technical transition out of fossil fuels and on the unlimited use of these fuels, rather than the unequal power relations that prompt a need for security and affordability [9]. Consequently, there have been calls for Net Zero policies to focus more explicitly on social inequalities so that policymakers better appreciate the uneven opportunities and burden on those involved – even when those burdens are carefully managed [8] to allow for collective and community-level inclusion in Net Zero policy and delivery plans [1]. A succession of studies has emphasised the need, not just for gender inclusion but for a wider intersectional approach that is inclusive of different inequalities [10] but also cite a lack of evidence to inform policymaking [2], including how principled commitments to labour and work can demonstrate their connection to social and environmental equalities in the future [4,11].

* Corresponding author at: School of Social Sciences, Glamorgan Building, King Edward VII Av, Cardiff University, CF103WT, United Kingdom of Great Britain and Northern Ireland.

E-mail address: macbride-stewarts@cardiff.ac.uk (M.-S. Sara).

In responding to this challenge, this paper seeks to address two key questions: a) how can theoretical debates in the equality and Net Zero literatures be 'bridged' to develop better integrated equality measures to underpin a Just Transition and b) what kind of systemic challenges might we need to overcome so policymakers can deliver those measures. We address these questions through an action research study based in Wales where equality mainstreaming has been deployed by the Welsh government as a tool to support Net Zero policy development. The process involved bringing equality and Net Zero specialists together with policymakers to develop collective recommendations and solutions.¹ The Equalities Mainstreaming Policy Development Model [12] resembles a systems methodology that considers the deep systemic roots of inequality, which are present in the ways in which economic and ecological processes interact with and exacerbate each other across the kind of societal developments promoted by energy modernisation. Our findings illustrate the benefits of equality mainstreaming in incorporating lived experience within policymaking but also highlight the challenges associated with implementing the systemic visioning that emerges. There are several theoretical and policy implications of our work. First, we advance the concept of 'eco-equalities', which refers to the specific and shared equality demands of an ecological crisis (e.g. prioritising resources for those most affected), that could enable a *just* transition from fossil fuels to environmental sustainability. This enables us to apply an integrative approach in order to: i) embed inequalities within Net Zero debates and policymaking ii) encapsulate different interpretations of justice and iii) incorporate lived experiences within policy responses. Second, and again in line with integrative thinking, we identify a series of linked policy challenges and offer suggestions on how these might be addressed.

The paper is set out as follows. The following sections introduce and discuss theory and evidence on Net Zero, Just Transition, and Equality Mainstreaming. This is followed by our methodology section which outlines our action research approach and details the background and role of our diverse set of research participants. We then present our key findings and in doing so highlight three key thematic priorities that capture the evidence emerging from the data: An ecological ethos; Net Zero redefined; Environmental upskilling. In the discussion section that follows, we advance the concept of eco-equalities and present this as a key construct which has the potential to bridge equalities and Net Zero literatures. The paper concludes by identifying limitations to our research and advocating a series of recommendations for policymaking.

2. Conceptual framework

2.1. Net Zero

The definition of Net Zero as 'achieving a balance between greenhouse gas emissions produced and those removed from the atmosphere' was normalised and institutionalised following the Paris Agreement in 2015 [13]. As a concept, it has played a central role in shaping the global response to climate change. Nationally determined contributions (NDCs) followed, as countries set out national climate plans to reflect how they would reduce their carbon emissions [14]. A call for the urgent reduction of emissions by 2050 was signalled by the 2018 IPCC report; subsequently many countries began to set out targets for achieving Net Zero. The translation of these targets into national capabilities and actions can be traced to much earlier roots, for example, in the work of scientists who suggested that CO₂ could be a tool for assessing climate impacts and mitigation [108,109]. Assessing these actions has required significant attention to policymaking as not all Net Zero targets are equal, with some only referring to CO₂, while others address all

greenhouse gases; some are legally binding, and others are policy statements or pledges [15]. Political economists too have expressed concern at how nationally determined contributions benefit richer countries, and elites who are economically active in poorer countries [16].

Net Zero has marked a significant shift in global climate governance [17]. By 2021, over 30 countries including the European Union were developing or had passed legislation to enshrine Net Zero targets [18]. The UK (followed by Wales) was one of the first to legislate for a Net Zero target by 2050 [19]. As in many countries, this Net Zero legislation sets out processes for reporting, reviewing and independent oversight, as well as detailed plans for key sectors in need of decarbonising, like energy, construction, transport and agriculture [14]. The focus is on a technical reduction of emissions, but Net Zero can only be achieved through a combination of political and economic actions and policies aimed at delivering benefits for the environment and society, and industry [20]. The UK's independent Climate Change Committee (CCC) describes Net Zero targets as ambitious and recommends scrutiny of their impacts and underlying goals [21,22,99].

One area where there is a need for climate governance scrutiny is in the labour market. For example, the transition to Net Zero is reshaping jobs and skills across sectors—from renewable energy and construction to transport and agriculture. Take the UK government's intention to support 440,000 jobs in Net Zero sectors by 2030 [14] as a case in point. The need for skilled technicians and planners for renewables, and the transport sector's requirements for mechanics for EV cars and buses demands new skill sets which may not be readily available in the current market. There are questions about how this workforce will be supplied, and whether the benefits of job creation are equitably distributed. For example, Net Zero sectors currently account for only 20 % of the workforce [14,23] and in line with existing workplace inequalities, they significantly lack diversity due to historical dominance by older, white, male, able-bodied workers [23]. This raises questions about the creation of a potential inequality gap, with the remaining 80 % of workers missed. It raises questions too about what is needed in policy terms for those remaining outside existing Net Zero sectors [23].

These exclusions demand policymakers' attention, as precarity in the labour market deepens ([24]). This is in response to technological developments [4] and dominant economic ideologies—such as those of Hayek and Friedman—that valorise market freedom while normalising structural exclusion and uncertainty as inevitable or even desirable outcomes. In contrast, other scholars have begun to interrogate why equity initiatives often fail to establish meaningful outcomes – highlighting the urgent need to reimagine what a truly equitable future might entail [1]. In answer, some equality-focused innovations attempt to embed Net Zero within broader social justice frameworks, resisting narrow technical interpretations. Yet while these efforts aim to build inclusive solutions that span Net Zero sectors, emerging technologies, and the diverse groups impacted by these transitions, there remains a striking absence of mechanisms capable of delivering this integration in practice [25,26].

It is often claimed that disparities emerging during periods of transition are temporary, with the expectation that businesses and governments will eventually adjust to align workers with the opportunities created by Net Zero initiatives [110]. However, such assumptions risk obscuring the structural barriers and policy failures that continue to exclude many from these transitions, reinforcing inequalities rather than resolving them. Feminist social reproduction scholars have long argued that capitalist organization of economics is largely responsible for the reproduction of inequality dynamics in society [27]. These dynamics include a lack of inclusion and engagement, insufficient resources to support participation, and a lack of robust mechanisms for evaluating the fairness of outcomes, especially for those linked to social reproduction rather than economic production [28]. They reveal how inequality is not simply a by-product of transition but a deeply embedded feature of the systems shaping it [100], and they call on a

¹ A paper reassessing the equalities mainstreaming method, and the adaptations to it for working collaboratively on-line post-Covid is forthcoming (Parken et al., in preparation).

necessary expansion of state responsibilities to counter these effects (Cörvers and Mahey 2021). The latter is illustrated by Nancy Fraser [36] who argues that without mechanisms to challenge existing economic marginalization, and the cultural privileging of certain forms of labour and expertise such as high value and high-status waged-work within the Net Zero energy industry, equality initiatives may remain symbolic rather than disruptive and transformative [29].

2.2. Just Transition

The concept of a Just Transition has emerged in response to these debates surrounding Net Zero and systemic inequality. Advocates argue that that existing disparities can be meaningfully addressed and that the uncertainty of future transitions can be managed so that 'no one is left behind' [30]. Just Transition draws on three schools of thought: one that frames the impact of change on industries and workers as a labour-orientated concern; another that views transition as a socio-technical and governance challenge [105]; and a third that approaches it through integrated justice frameworks and public perceptions [2]. The first school of thought, rooted in the ILO's [123] framing of Just Transition, shifts focus from mass industrial change to the remediation of workers, future job availability, and quality and distribution of employment. The second, from socio-transition and governance perspectives, highlights the deep structural shifts required in energy transitions - across social, technological and political systems, and the challenge of ensuring community involvement and equitable benefit sharing amid pressures for rapid change [2]. The third draws from climate, environmental, and energy justice, emphasising activist and stakeholder perspectives on how inequality shapes the experience and outcomes of transition, particularly for the most vulnerable [98,102].

It is Wang and Lo's [2] framing of a just transition that acknowledges that injustice is understood in diverse ways. Although there is a shared concern for identifying vulnerable groups there are different understandings of who is vulnerable, ranging from workers displaced by the shift from coal to renewables, to households unable to afford renewable technologies. Furthermore, while governance and political systems are recognised as central to achieving justice, tensions arise over how they can be mobilised, and what constitutes a just process - whether financial renumeration or inclusive decision making [93]. Crucially, the mechanisms by which these pathways are chosen remain opaque, raising questions about whose interests are prioritised, and how power and finance shapes the trajectory of a transition.

All these reflections on the concept of a just transition have contributed to its pluralization [31,32]. Over time, the narrow framing of a Just Transition as an outcome-focused concept – concerned primarily with the configuration of jobs and skills in a Net Zero economy, has expanded to include a more critical emphasis on pathways to justice. This shift foregrounds questions of *how* we transition equitably from our current socio-economic conditions [4] and whether pathways need to account for contextual factors [33], values [34] and political will [35]. Galgóczy [4] conceptualises these varied representations of a just transition pathways across a continuum. At one end is the emphasis on *shared responsibilities* that largely preserve existing balance of power structure among governments, businesses and vulnerable groups. At the other end are *socio-ecological* approaches that seek to reorganise the relationship between social, environmental and economic systems [40] offering more radical and inclusive possibilities. Between these lies the notion of *differentiated responsibilities*, which target sector-specific inequalities but risk overlooking broader systemic inequalities [4].

From our perspective, differing just transition pathways need to reflect complementary strategies for addressing power imbalances rooted in global capitalism and cultural domination. Drawing Fraser's [36] work, scholars have identified distributive, procedural, recognition and capabilities-based processes, arguing that these offer practical and pragmatic pathways to confront Net Zero inequalities [37]. *Distributive* justice addresses the uneven allocation of transition costs and benefits

aiming to redistribute resources to those most affected and vulnerable groups [35]. *Procedural* justice highlights the inclusion of vulnerable groups from meaningful, sustained participation in decision-making. *Recognition* justice challenges the assumption of social and political equality, urging attention to intersecting vulnerabilities. *Capabilities* justice shifts focus from deficits to people's potential to act, even in ways not yet recognised [38,39]. Scholars also extend the framework to *restorative* and *epistemic* justice which address historical harms and elevate diverse knowledges and lived experiences [40].

In policy contexts, Just Transition thinking is evolving into a more integrated understanding of harm and vulnerability [31], moving beyond redistribution to embrace a cultural shift that values valuing diverse knowledges, skills and lived experiences. A socio-ecological framing foregrounds the role of frontline communities in decision-making [41,111] acknowledging their perspectives on rights [42], livelihoods [38], power relations [46] and differing interpretations of inequality and justice [26,43]. Importantly, it also opens space for contestation and alternative actions and pathways, reflecting the complex, bottom-up and socio-ecological politics of transition [34,37,41,112]. Both approaches fail to provide insight into why the groups who were originally targeted by facilitative policies like Just Transitions fail to enter the workforce through it [27].

2.3. Mainstreaming as an underpinning mechanism

The evidence presented above underscores the contested nature of the public discourse of Just Transition and the need to interrogate whether inclusive and context-sensitive – even co-productive- methodologies can navigate the competing justice claims and multiple pathways to a Just Transition. Presumably, greater inclusivity must engage with the deeper structural reconfigurations proposed by socio-ecological approaches to do more than merely accommodate difference; but actively challenge dominant paradigms, and open space for plural knowledges and transformative imaginaries [4].

Gender mainstreaming reflects such a methodology when applied with a transformative lens [96]. As a well-established policy development method [44] it aims at putting equality into practice [124] by developing policies from an equalities perspective [45], promoting intersectional thinking [46] and employing EDI assessment tools such as gender-disaggregated statistics and equality indicators. While traditionally aligned with differentiated responsibilities and structural transformation, gender mainstreaming can also serve as a vehicle for the kind of radical inclusivity envisioned by socio-ecological approaches especially when it moves beyond technocratic assessments to interrogate the intersecting institutional, legal and cultural systems that sustain inequality [95]. Indeed, studies by scholars using gender mainstreaming, indicate that it has clear positive effects for the participation of activist groups working informally with those with negative experiences of other policies intended for them, like STEM education [47,48].

The problem with more moderate, inclusive frameworks is that they may propose policies to the advantage of those with the most resources to participate. They fail to appreciate that the energy sector workforce is not exclusively technical or male, and that conventional equality-focused methodologies like Equality Impact Assessments have well-identified problems with data robustness. Yet, multiple means of embedding inclusivity into broader justice-oriented epistemologies have been advanced, in an effort to not risk reproducing systemic exclusions [4]. This includes an examination of state-led policy discourses to show how they shape perceptions of harm and benefits across regions, and communities [26,49,113] to offer an entry point into capitalist structural critique.

Gender mainstreaming offers a complementary lens capable of interrogating gendered and intersectional experiences and local contexts into Just Transition policy planning, paying attention to both discourses and actions. Its application in the energy sector has intensified attention to gender-sensitive concepts like energy-use systems, and opened up

structural planning options, including more gender-aware governance and decision-making [50]. However, its transformative potential depends on how it navigates two interrelated struggles: one focused on global hegemonic structures that cement inequality through entrenched power relations, and another grounded in pluralistic commitments to recognition inclusivity, and justice. These latter struggles manifest through procedural and distributive justice in energy system design [51], stakeholder collaboration [52] and attention to everyday gendered energy-use practices [53], as each are shaped differently by local conditions and emerging inequalities such as the energy-gender-poor-urban nexus, first identified in rapidly transitioning regions like Africa [51]. It reflects the highly contextual nature of the policymaking reached in gender mainstreaming in the distribution of costs and rewards,

Together these struggles illustrate how gender-mainstreaming when aligned with socio-ecological thinking – can help reframe Net Zero not merely as a technocratic carbon-reduction agenda but as a site of competing and interrelated justice claims. This framing has prompted a shift in the energy sector's perceptions of a Net Zero transition, solidifying the relevance of equality and the need to manage labour transitions through inclusive, participatory decision-making [46]. This emphasis is where we now turn; to a methodology for the inclusion and consultation with vulnerable groups [54], to understand how inequalities are exacerbated by institutions, cultures and policies [55,56]; and attention to the multiple equality concerns of a wider Net Zero skills transition in Wales and the growing pluralization of Just Transition goals [57].

3. Case study and methodology

3.1. Research approach

This section reports on the action research approach and design adopted in this instance. Action research has been characterised by Eden and Huxham [58] as 'an involvement with members of an organization over a matter which is of genuine concern to them' (p. 75) so we would usually associate action research with a broad motivation to achieve change that is then captured within a specific intervention. Thus, researchers are not neutral observers but actors 'within a dialogical process structured by both the researcher and the researched' ([59], p. 6). There are a series of benefits associated with action research methodologies, including the nuance and insights that they offer which are difficult to gain through other methodological approaches [58]. At its heart of action research is a core assumption that research subjects have an ability to interpret their own circumstances, appreciate the issues they face and have the potential to address them [60]. In addition, action research enables researchers to produce benefits at the point of action through a joint endeavour designed to deliver democratic and social change.

We consider action research an appropriate research approach for this study given our aims to a) identify ways to bridge literatures on equality and net zero in the context of a Just Transition and b) consider how to support policy-making and as because it offers scope for research that 'challenges unjust and undemocratic economic, social and political systems and practices' ([60], p. 11). In this case, the research team had the opportunity to work with participants, including equality experts to impact equality mainstreaming within policymaking and facilitate the generation of policy ideas and prescriptions related to Net Zero, to show how equality is variously understood in a green transition.

Our equality mainstreaming pilot (which represented a re-test of the

Equality Mainstreaming Policy Development² Model) is a qualitative participatory action research method used in this iteration to investigate Just Transition in practice [12,61]. Action research and equality mainstreaming are considered highly complementary approaches for tackling complex challenges [94]. This is because action research involves long-term involvement with a group through iterative stages - planning, acting, observing and reflecting, - while equality mainstreaming uses these stages, emphasising experiential 'expert' knowledge, active contribution (including evidence-production) and collaboration. Together, they are designed to address unequal power dynamics by linking theory with practical solutions in a way that promotes co-learning and foregrounds inclusive change [62,114].

It is important to note that action research constitutes more than 'doing good' but is also focused on doing research well ([60]: 25), with a clear imperative to produce high quality data and informed insights [58]. In this case, we have ensured that our action research processes meet quality standards, such as those proposed by Eden and Huxham [58], so that our data collection and analysis processes can underpin conceptual and theoretical advances.

3.2. Research context

Net Zero Skills was selected as a case for equality mainstreaming in Wales due to its intersection with entrenched inequalities and varying sectoral approaches to addressing them. Wales already has a lower-than-average rate of skilled jobs compared to the rest of Great Britain [63], with part time jobs -over 80 % of which are held by women – often being the lowest skilled. While predictions suggest some stability in the types of skills and jobs required for Net Zero, there is some uncertainty about whether sufficient workers can be retrained or require new jobs [24]. This reflects uncertainty not only about job supply, but also the demand from employers and employees, a key issue discussed further later. Net Zero skills policy is devolved to the Welsh Government although energy is not. At the time of the research, the Welsh Government Economy and Skills Division were beginning work on a Net Zero Skills Action plan, including thinking about engagement to build policy ideas. Since this was a national plan, we limited the geographical scope to the national rather than the regional level like transition towns or sectors. Together with the Equality and Human Rights Division of the Welsh Government, who sponsored the re-test of the Equality Mainstreaming Model. It was agreed that this live policy area was suitable in terms of its importance, scope and timeliness.

3.3. The research process

The research project constituted a series of six, 3-hour action research workshops, held online over a period of 6 months, from January 2022 to July 2022. Fourteen representatives of equality and sustainability organisations, think tanks and trade unions, along with policymakers and business were invited to join the group. Carefully selected because of their expertise, the group included equality practitioners who represented organisations (and lived experience) covering gender, ethnicity, disability and religious; along with others with specific expertise in delivering Net Zero training and education, or sustainability, in Wales. The inclusion of different equality groups is a novel approach, but one the research team use for equality mainstreaming, to ensure that their expertise remains the central point of discussion [115]. It also meant that most participants engaged consistently throughout, although some occasionally sent substitutes, meaning that during the 6

² The Gender Mainstreaming Policy Development originally developed for the Welsh Government to address intersectionality in policymaking to meet their mainstreaming equalities statutory duty (s.75 GOWA, 2006), and Department for Culture, Media and Sport as the EHRC was being established [12].

months, 25 different participants representing the same organisations contributed over the research period. Formal invitations and preparatory training were provided by a member of the research team.³ Profiles of panel organisations can be found in [Appendix 1](#). They had each consented to the research through an approved ethics process.

The equality mainstreaming [12] research focused on one overarching question '*what is needed for an equitable future for Net Zero skill and jobs in Wales?*' and comprised five key stages, conducted concurrently across the workshops described earlier (see [Fig. 1](#)). Workshop-Stage1/WS1 involved exploring what Net Zero offers in terms of equality and a just transition. Workshop-Stage2/WS2 focused on mapping the Net Zero policy field from an equalities perspective; a task that involved the group presenting evidence and insight based on their expertise and the voice of their communities [64]. In Workshop-Stage3/WS3 other experts (such as those working in skills policy) provided an evaluation of approaches that might support equitable decarbonising or training/education, providing opportunities for reflexive and collaborative discussion. In Workshop-Stage4/WS4, the meeting focused on 'visioning', a method which consolidates prior discussions and evidence to enable the group to set out achievable solutions for policy change or development. Finally, Workshop-Stage5/WS5 focused the panel's novel insights and proposed monitoring, evaluation, publishing of visions, including as their response to calls for evidence Net Zero policy or programmes [61].⁴ The final Workshop was a review of the process and opportunities for sharing new evidence and learning.

3.4. Analysis

The process generated a dataset that comprised 18 h of transcribed recordings, policy documents, panel presentations, and notes made by the research team. In the visioning stage of the action research, five policy-making visions or themes were developed: Changing Workplace Cultures; Job Redesign, Greening Care; National Climate Programme; Climate Literacy for All. These represented a set of interventions focused on widening participation in Net Zero and offered potential pathways to equalities and Net Zero skills and jobs. The five themes which had been co-produced through the participatory action research process, reflected the reflexivity, reiteration and validation by the panel members who had refined and agreed the themes at each action research stage.⁵ The findings were also confirmed at a series of consultation meetings focused on Net Zero skills and jobs held by Welsh Government, at which research team members spoke independently.

For this paper, a second stage poststructuralist discourse analysis of the five 'visions' was conducted [65]. Initially, transcripts were re-read in-depth and reanalysed (by SMS). The five visions were used deductively as thematic labels, with analysis focused on the framing used to construct each vision and the proposed pathway to equality. Hollway and Jefferson's [116] psychosocial approach was helpful in focusing attention on thinking critically about the social reproduction of inequalities, as was Haraway's [117] invocation to 'stay with the trouble' which places emphasis on thinking with rather than, about ideas - in this case the lived experience of inequality and the conceptual gap between Just Transitions and Net Zero. A final consolidated set of thematic priorities was agreed and validated by the members of the research team. Our findings are discussed in the following section of the paper.

³ Constituting the panel and setting agreements for joint working is discussed in a separate sister paper (Parken et al. in preparation).

⁴ This is also summarised in the Chwarae Teg Phase 2 main report, 'Deeds not Words' (2019).

⁵ The qualitative data is summarised in an open access report for Welsh Government 'An Equal and Just Transition to Net Zero' [24].

4. Research findings

The panel collectively proposed and agreed a set of pathways that they felt offered equitable governance strategies for Net Zero skills and jobs. One initiative focused on embracing an *ecological ethos and cultural transformation*, another *redefined* Net Zero work and while the remaining two prioritised *upskilling* of environmental knowledge and skills. The **ecological ethos** approach shifts the focus from jobs to the relationships between workplace cultures and equality, and an emphasis on sustainability. The **redefinition** approach involves widening the conceptualisation of Net Zero work, to include carework. The **upskilling** approach describes a process of enhancing citizen empowerment-through climate literacy and a national climate service. These are also presented in [Table 1](#) and discussed below. Our framework highlights how these proposed pathways reflect the dimension of public perceptions considered by Wang and Lo [2], which in the context of work and skills equality is shaped by an expectation that culture and intersectionality are addressed.

4.1. Shifting towards an ecological ethos

The Welsh Government's Net Zero plan follows the Climate Change Committee's focus on the most highly emitting sectors, depicted in [Table 2](#). This posed a challenge for the panel because the Welsh Government does not have devolved responsibilities for all Net Zero sectors, including energy. At the same time, the success of the government to improve access and retention to different sectors and jobs through improving diversity and reducing work-based inequalities, has been uneven [24]. In response, the panel proposed a shift in policy focus based on two proposals: a focus alleviating unfavourable cultures of work in existing Net Zero sectors (a strategy that is linked to other STEM sectors but which is considered especially urgent for Net Zero), and an effort to integrate non-technical skills and other sectors in Net Zero skills policies, including ecological.

4.1.1. Alleviating unfavourable cultures of work

The panel raised a critical concern about the persistence of unfavourable work cultures within existing Net Zero sectors. Despite being framed as 'new' or innovative, these industries often replicate existing cultures and structures that marginalise certain groups – particularly through poor recognition and persistent capacity gaps. For instance, the dominance of the steel sector in Wales has fostered a culture of familial job succession [66], reinforcing concerns about access for women and minoritised ethnic communities. Taken together, these claims reflected the legacies of previous transitions and concerns that even a focus on 'skills' (i.e. decision-making) rather than labour (i.e. physical jobs) reinforced exclusionary practices and limited broader workforce diversification.

[Steel] is a very middle-aged old workforce and the industry faces problems recruiting workers to replace its retirees...[It] requires knowledge transfer between generations.

[WS3]

There's need...to tackle the culture and infrastructure of the [steel] industry...some of the plants we've listed in Italy and elsewhere, there's no changing facilities for women that are part of the production process. There's a need for awareness campaigns to target and intensify treatment of women and migrant workers...to disseminate best practice...and tackle discrimination at all levels. [T]he industry needs to make clear these are high skilled jobs that are not physically intensive as they once were... focussed more around...data analysis skills, green skills and decision making skills.

[WS3]

Decarbonising sectors were characterised as having an ageing predominantly white male workforce – a demographic that constrains

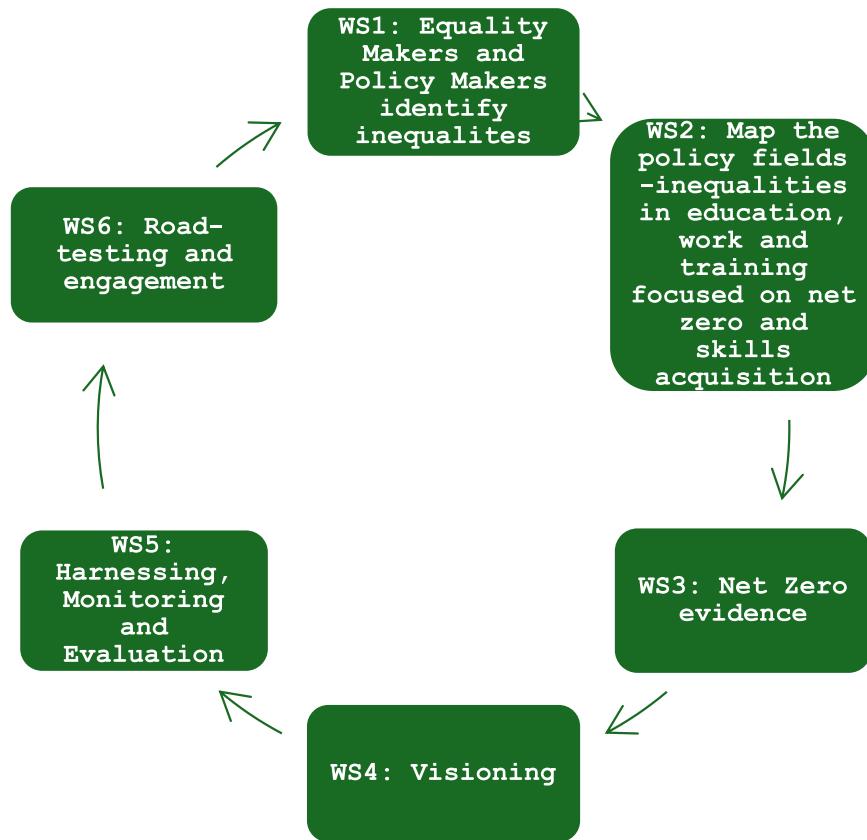


Fig. 1. The equality mainstreaming policy development model adapted for Net Zero mainstreaming.
(Source: Parken [12] (WS = WorkshopStage).)

efforts to diversity and modernise workplace cultures. This entrenched norm contributes to what Pearl-Martinez and Stephens [67] describe as an ‘energy diversity gap’, which poses significant barriers to cultural transformation. As highlighted by our Evidence Panel, fears of poor treatment, discrimination, being undervalued or simply not being heard, contribute to a set of ‘chill factors’ – subtle but powerful deterrents that underscore the importance of addressing the cultural dimensions of workplace inclusion [3].

The panel recognised that workplaces lacking diversity - or failing to adapt to it - struggle to overcome entrenched inequalities. To avoid repeating patterns of exclusion and improve retention, both cultures and structures must transform. Panel discussions drew on sectorial (e.g. STEM) and systemic (e.g. Covid-19) examples to illustrate this need:

You don't actually change the culture, and they leave. We're bringing people into an organization that sets up this structural racism is already in a very kind of male dominated. Then the people won't progress...the stories...of being the only woman electrical apprentice [with] your toilet [being] a half a mile away.

[WS4]

While some large companies are making progress on workforce diversity [68], many still lag behind in ensuring equitable career and pay progression [69]. These gaps are evident across retraining and upskilling programmes, as well as in various green projects [67,70].

If we need any sort of reskilling, upskilling, employability, training, support to get people into sectors that they're not currently working, we have to make sure that there's childcare support [...] we're still designing employability programmes without childcare support and then wondering why women aren't accessing it...

[WS4]

‘Access for all’ programmes remain particularly challenging, as opportunities to get involved are not equally distributed – even when talent and engagement are. For example, the Welsh Government’s Flexible Skills Programme [107] targets retraining within existing energy and construction workforces, potentially reinforcing demographic imbalances. The panel highlighted organisations such as Babbosa in Bristol, which partner with industry to build restorative justice-based social partnerships, offering young people opportunities aligned with their talents, contributing essential skills for a just transition.

...you often find younger workers coming in with the more up to date digital skills that are required, which can be transferred to older workers.

[WS3]

The panel recommended that the Welsh Government foster social partnerships by creating ‘trusted gateways’ to training providers and workplaces with inclusive cultures – such as anti-racist practices – and offering coaching and mentoring for employers. Evidence of increased female enrolment in agricultural training in Wales, and efforts within the steel industry to ‘reframe’ its work as meaningful and ‘green’ were shared as signs of growing attention to workplace culture. Given the extensive literature on women’s contributions to decarbonization, the panel stressed the importance of drawing on sectors not dominated by men [71,72]. This view of partnerships to ensure that women are not left out of existing schemes, points to efforts to address an incomplete understanding of the role of marginal groups in the ‘green’ economy. As indicated by existing critiques, marginalised groups have long been subject to the assumption that targeting access is enough to make these workplaces attractive for them.

Table 1
Equalities pathways for Net Zero Just transition.

Pathway	Description	vision
Shifting to an Ecological Ethos	Refers to the interplay between existing Net Zero sectors, employers, employees and the arrangements for new cultures of work through the creation of new spheres for workplace equalities, or the adjustment of existing ones. Represents a form of redistributive thinking and the potential for work to be greener, more equitable and more highly valued	Alleviating unfavourable cultures of work; Including environmental skills and people not yet included in Net Zero
Redefinition of Net Zero Work	Proposed redefinition to include jobs and skills aligned with a capabilities approach. This redefinition process can be seen as an attempt to add new sectors to the Net Zero jobs market. The equalities approach learns from previous transitions and considers how equalities can be integrated as part of digitization and socio-technical developments especially in male dominated sectors	Adds sectors not automatically considered as 'green jobs'
Environmental Upskilling	Specifies the different ways in which the relations between equalities, 'benefits for all' and investments can take shape in the context of Net Zero. Redefinitions of inequality, and epistemic justice are key processes that characterise these interfaces.	Climate literacy for all and National Climate Service

Table 2
Net Zero priority decarbonisation sector and skills.

CCC sector	Specific pathways for Wales	Skills examples
Surface Transport	Transport/Planning; Electrification; Travel Behaviour	Policy; data/digital; vehicle production & maintenance (all types); 'drivers'
Electricity Supply	Alternative electricity forms; decommissioning; production; distribution; storage	Policy; R&D; logistics; engineering; monitoring
Aviation	Flight/Airport planning & demand (International and domestic)	Maintenance; 'Pilot'; production; Travel and goods industry etc.
Shipping	International and domestic	Fuel supply;
Residential and non-residential buildings	Low-carbon, heat, and energy efficiency/measures inc. retrofitting and new builds	Retrofitting; new builds; services (heating/water); fabrication/insulation; waste; evaluation design/survey/trades
Manufacturing/Fuel Supply/ Construction	Emissions reduction	Supply; Materials; Waste; Engineering; Trades

(Source: adapted from the CCC reports (2020–2021).)

4.1.2. Including skills and people not yet included in Net Zero

both paid and unpaid care work are at the heart of a green transition, and that the care sector is already a low carbon sector. The formal care sector not only creates jobs for many but is also fundamentally embedded

to the wellbeing of us all. Despite this, many green economy plans overlook care entirely

(Turkman, p.15)

The panel emphasised that a Net Zero approach has the potential to drive cultural change – but only if extended to include skills and groups currently excluded. By framing Net Zero through this inclusive lens, the scope of what counts as a “green” job can be broadened to encompass roles that support precarious and insecure workers. This, the panel argued, is a form of distributive justice – recognising and valuing low-carbon sectors and decarbonization efforts that are often overlooked.

it's not just the sectors [already] identified...everybody can contribute...if you think about...upskilling...a population of workers who are not low skilled, but are low paid, you are adding skills and...adding to progression in the foundation economy. [This is] much wider [than] workplace inequalities...and redesign.

[WS4, union representative]

Feminist scholars have argued that upskilling low-paid workers represents a manageable and meaningful expansion of re/training and career progression opportunities. Evidence from the Women's Budget Group [73], shows that social investments in care linked to Net Zero, could significantly boost employment - producing 2.7 times more jobs than equivalent investment in construction, including 6.3 more jobs for women and 10 % more for men. While the panel acknowledged the urgency of upskilling, they also debated whether simply relabelling of jobs as ‘green’ was sufficient, warning that without structural change, these jobs risk being devalued [74,75].

As a form of feminist redistributive thinking, the Women's Budget Group [73] highlights the care economy's potential to be greener, more equitable and highly valued. Their analysis points to well-paid jobs in the Welsh NHS as contributing to Net Zero goals [73]. However, despite the vital contributions by women, minoritised ethnic groups, and low-paid workers during the Covid-19 crisis [118], the panel argued that a deliberative shift is needed to ensure the “green potential” of this sector is recognised and not overlooked:

we know 80 % of the [care] workforce is female. With many women from minority ethnic backgrounds, especially in the lowest paid, having the most precarious roles in that sector...we think there's a really strong case that these jobs are green jobs

[WS2]

We don't want...to widen the inequality gap between professions like care...we want to more highly value and give, give greater status to [care] through this process....[and] is not further disadvantaged in the move to this new economy

[WS4]

It's recognising that care is a sector that is inevitably going to have to grow and, that it can grow in a way that is more green.

[WS6]

The panel debated what cultural and structural shifts are needed to include new skills and people in Net Zero. They concluded that boundary struggles over what counts in Net Zero strategies must be addressed. However, to understand inequality that arises from Net Zero and to foster justice, this proposal can be aligned to social reproduction critiques that identify that the redistribution of waged work - so that all jobs are defined as green - may be problematic [27]. Firstly, it does not address the question of how some jobs retain their higher status, and secondly, how all current forms of work will need to become even more green in the future. Their proposed approach includes re-categorising Net Zero jobs and skills to encompass health and social care, and this is suggested as a proactive effort that anticipates how such a shift starts to take place. This is discussed next.

4.2. Redefinition of Net Zero work

how do you include people in that kind of whole employability and skill system? And that's the distinction...skills [you get] in context of your life now [which may be] about economic inclusion as part of this just transition, as well and removing some of those barriers

[WS6]

The panel proposed a policy restructuring to expand the sectors included in Net Zero strategies. From a feminist perspective, the current focus on the seven most polluting sectors [14] is too narrow. Instead, they called for a redefinition of Net Zero job work – recuperating broader understandings of jobs and skills aligned with a capabilities approach. This includes recognising undervalued care sectors, such as health and social care, and draws on literature advocating for job redesign and re-evaluation as seen in Equal Pay legislation (see also [76]). It is aligned with feminist critiques that argue that the best way to ensure that jobs are distributed fairly – and that concerns about the loss of existing well-paid fossil fuel industry are met- must be addressed by challenging the hegemonic distinction between waged (productive) work and low-paid or unpaid (reproductive) work. It does so by setting its sights on redefining the categories of Net Zero work as both a technical and a political effort at participation.

To do this in the context of Net Zero, the panel argued that the redefinition of its work should move beyond the existing displacement-replacement model of job transition. While the UK's Climate Change Committee [77] focuses roles within the seven most polluting sectors, the panel advocated for a broader approach – drawing inspiration Scotland's *Climate Emergency Skills Action Plan* [103] which recognises 'new jobs', 'jobs that we will need more of', and 'jobs that will change'. This inclusive framing supports the integration of additional capabilities into training and reskilling for the Net Zero transition:

- 1) *New and emerging jobs directly related to the move to Net Zero*, for example: Fuel Cell Technicians, Carbon Monitoring Technicians, Hybrid Tech Engineers.
- 2) *Jobs affected by the transition requiring new skills/knowledge*: Architects/Surveyors/Environmental Consultants/Transport manufacturing and engineers.
- 3) *Existing Jobs that will be needed in greater numbers*: Designers industrial and product, Plumbers, heating and ventilation, renewable energy engineers, Control System Engineers, Biodiversity and Land Management (Scottish 'Climate Emergency Skills Action Plan' (2021).

The panel then proposed panel a fourth category

- 4) *Sectors not automatically considered as having 'Green Jobs'.*

- i. Social care and childcare (currently low emitting and needed to support those in education, training, upskilling),
- ii. Education (new research and teaching),
- iii. Health (innovation - new products (e.g., less aerosols) and surgical processes.

In this redefinition approach, the typology expands opportunities for groups traditionally associated with non-technical, caring, or 'social reproduction' roles [7]. At the same time, it promotes a vision of 'green jobs' that includes emerging technical, digital or AI-based work – blurring boundaries between home-based and transferable labour. The panel argued that this inclusive framing adds transformative potential to Net Zero by addressing the exclusion of many from current skills and employment strategies and particularly targets the question of whether gender equality can be achieved regardless of Net Zero being realised or not. In fact, the principle of equality at work here, seeks to redefine the conventional boundaries between Net Zero as productive-masculinized-work and green jobs as reproductive-feminised-care as the basis on

which Just Transitions is predicated [27]. This requires a critical de-gendering of work, which as one participant in the final session put it:

*It is going back to some of the basics really with service design but from a gender perspective...it's about flexibility, it's about support with care so that people can engage. It's about supporting people who are not well represented in those sectors to understand that **there is a place for them and a career path for them**.*

[WS6]

Additionally, it is about not repeating past mistakes:

*We've been through this whole thing in the knowledge economy. What we're trying to do is avoid that and make sure that, you know, **there are opportunities for everyone** by not describing certain sectors as green and everybody else....not*

[WS6]

The panel's arguments suggest that Net Zero offers the potential for a new institutionalised form of emancipation - where all forms of work, including those that are traditionally undervalued can be recognised as green jobs:

*very clearly [what's been] said in the last few weeks. That **there are missing jobs that...should be brought within this green envelope**. Not just the jobs that absolutely address the reduction of emissions, but jobs that are already low emitting where further investment could help us meet our carbon targets..particularly social care, jobs that are devalued, lack of progression, often precarious work.*

[WS4]

*Job redesign...which highlights, you know, **education, health and social care** as an area that skills might have might need to provide a particular impact...*

[WS6]

The panel noted that redefinition of Net Zero work offers important insights into restorative justice. It exposes a contradiction: even in diverse and progressive workplaces like the NHS, wages and conditions are deteriorating. Care labour, once performed by more privileged groups, is increasingly transferred to poorer and ethnically marginalised women [7]. To meaningfully include care in Net Zero job strategies, the panel stressed the need for opportunities that support both vertical as well as horizontal work mobility:

*[T]wo particular programs [digital ICC, advanced manufacturing/engineering] because are male dominated...[about] 30 % of those people starting are women...we are looking at **expanding** the degree apprenticeship program [to] create some more diversity. But ultimately that's not solving the problem for...people not going into advanced manufacturing, engineering and digital...*

[panel participant WS4]

The panel's redefinition of Net Zero centres on how equality can be advanced by including new jobs, sectors, skills and workers. This approach highlights the tension between enhancing capabilities and achieving restorative justice – particularly in recognising and valuing those who perform care work. Including underrepresented sectors like care requires not only expanding the definition of Net Zero jobs but also ensuring that people doing this work are meaningfully compensated and given the time to contribute.

4.3. Environmental upskilling

*What we landed on [is] climate change related jobs and...avoiding sort of segregating people onto...siloed subject pathways and majors, and actually the need to be thinking more about the ... **broader skill set** that are the building blocks for a whole range of things that you could do in that space.*

[WS4]

While just transition and climate justice are well-established in social movements and academic debates [78] – the panel introduced a third theme focused on environmental upskilling and inclusivity. This centres on epistemic justice- recognising the rights of all members of society and not just workers -to access and offer -climate knowledge and skills. The panel proposed the practical measures of carbon literacy and a national climate service, framed as “benefits for all”, to rebalance access between those currently included and those excluded from Net Zero education and training.

4.3.1. Literacy for all

carbon literacy across the board is has to be a really, really important part of the net zero action strategy around skills. A broad spectrum carbon literacy program available to anyone of working age in Wales free.

[WS4]

The panel described carbon literacy as essential to a Just Transition. It refers to the interconnected knowledge, beliefs and learning that enable engagement and reflection - creating pathways to epistemic justice through ‘bottom up’ investment. While the concept is well-established, with evidence of its effectiveness across diverse groups including children and those with low literacy [79,80] the panel offered an expansive and inclusive framing of climate literacy focused on contextual practices [119] and decision-making [81], as a foundation for environmental upskilling:

*[not] just a concept, but with a real focus on [training and equipping and empowering] people...within that sector to **understand the carbon implications of the work that they do**. And then let them figure out... they'll do amazing things, they'll start creating the initiatives that we can't imagine.*

[WS4]

The panel argued that expanding Net Zero jobs and skills opportunities depends on mass carbon literacy. They identified two key features: first, *commoning* [82], which supports collective access to climate knowledge when rights alone are insufficient [83]; and second, *addressing the skills pipeline*, which supports a structured pathways through which those currently excluded can access to knowledge, training and opportunities needed to participate in Net Zero work. By linking education and the environment as shared cultural assets, the panel framed carbon literacy as a foundational tool for upskilling and epistemic justice. It is a strategy supported by social reproduction theorists who agree that commoning can addresses the struggles of all citizens- and therefore the public bodies whose responsibilities it is to protect education rights not as workers, but as citizens within a capitalist economy.

As such, addressing the skills pipeline was seen as an essential for equality, involving: i) linking participants to entry-level projects that build experiential climate understanding (e.g. community organizing, grow-your-own initiatives; ii) signposting new jobs, training, and job redesign services iii) providing advice, resources and pathways into Net Zero projects iv) ensuring equality-focused resourcing and information. Panel members suggested the scope of mass carbon literacy extends to engaging personal, active commitments to Net Zero. An integrative approach that does not take the workplace or equality as taken-for-granted was emphasised:

I'm talking about the need to...integrate carbon literacy training into ... existing qualifications and thinking about that as part of sort of leadership training. Making sure that leaders are equipped with understanding...equalities as well, so that we've got people who can make decisions about those two things together

[WS4]

The panel also recognised that a key place for marginalised groups to learn may exist outside mainstream pathways. They advocated for a

capabilities-approach rooted in community organizing, and the opportunity for this to shape understanding of the political and economic structures underpinning climate change. They emphasised as commoning does not automatically prioritise uptake among unemployed individuals, those not in education, and people from SMEs or priority communities. Novel efforts may be needed to locate multiple needs and to equalise carbon literacy.

Rather than targeting those only presumed to lack knowledge, the ‘carbon literacy for all’ approach should be understood as part of broader institutional delivery to show how every person and job can differentially contribute to decarbonisation. It is up to mass carbon literacy to address diversity as such. Notably, because those who rate themselves as highly knowledgeable are found to have higher perceived knowledge than actual understanding, how capabilities are addressed must be critically assessed [84].

The panel emphasised that mass literacy requires governance oversight. They recommended that the Welsh Government facilitate new equality interfaces by supporting carbon literacy start-ups and harnessing citizen engagement through climate assemblies, community hubs, local volunteer groups like Women's Institutes. Learning should also draw from industry and trade unions, such as the Wales Union Learning Fund (WULF), and research on the steel industry and home-working impacts. The panel favoured peer-led and co-learning models over top-down approaches, advocating for a ‘train the trainer’ method to cascade learning (see Sustain Wales):

*I think our hope was...[climate literacy] is something that [business] was talking about, ...if you **learn that on the job**...you take that out to your wider community and friends and family*

[WS4]

*this golden thread...of carbon literacy [is] the **broader skills and knowledge** that everybody's going to need...that baseline sort of knowledge and skills everybody's going to need has really stuck with me....it's got a lot of synergy with thinking [from]... digital and automation.*

[WS4]

While carbon literacy is not new to Welsh Government, the panel recommended moving beyond individual public body pledges [85] by embedding a carbon literacy programme within the proposed National Climate Programme (below). This avoids a top-down, behavioural change model and instead promotes epistemic justice – building communities of practice, and enabling systemic, inclusive learning, rooted in the involvement of frontline communities [86].

4.3.2. National climate service and skills for all

The idea here is a National Climate Service. [Y]ou directly employ the builders of wind, solar, wave and tide. We create our renewable sector. We retrofit and insulate the buildings, we install the heat pumps... By doing that...we're also addressing fuel poverty...[I]t would kick start the whole training system. ...[I]f we were to invest in employment, through existing schemes and direct employment...then training providers know exactly what it is that they've got to get geared up to provide. It would then exist as a training and skill system...for unemployed people, people who are economically inactive, people who want to retrain. [O]nce that skill system is in place, it's there then to benefit other businesses....So it pushes everything forward

[WS4]

The panel recommended establishing a National Climate Service, inspired by the U.S. Green New Deal's Civilian Climate Corps – itself modelled after Roosevelt's 1930's Conservation Corps. In that initiative, state governments were given 90 days to mobilize the next generation of conservation and resilience workers [87]. The panel saw this as a way of institutionalising inclusive environmental upskilling and carbon literacy at scale.

The panel emphasised that integrated training and employment is critical to meeting Net Zero targets, underscoring the scale and urgency of the transition required [120]. The Campaign Against Climate Change [121] estimated that one million UK energy jobs could be created across sectors such as retrofitting, renewable energy, electrification, and heavy industry decarbonization. In Wales, however retrofitting 50,000 older homes remains a major challenge - hindered by slow investment and limited progress over the past decade [120].

The proposal for a National Climate Service foreshadowed what later developed as a proposal for a National Nature Service⁶ – an initiative aimed at addressing skills in the natural environment sector. However its scope remains limited, leaving broader business and Net Zero workforce needs to be addressed by a proposed future National Climate Service. The panel drew on survey evidence to assess the potential success of such an initiative, highlighting strong interest among young people to work in roles that support decarbonisation and environmental change. Notably, 83 % of employees in one study reporting willingness to contribute to climate action through their work, yet lack clarity on how to do so [84,88].

The panel's proposal for a National Climate Service reflects a reimagining of how to bridge inequalities through the evolving definition of 'green jobs' - linking knowledge, training and employment. In the Welsh context, particularly in the renewable energy sector and government investment in existing businesses, the panel emphasised the need for new economic-political structures to foster partnerships and inclusive enterprises. Emerging initiatives to build a Net Zero housing stock were also highlighted, including tax incentives, grants, and loans aimed at helping landlords improve energy efficiency in homes and public buildings [89]. These measures were seen as vital to aligning business activity with workforce development, and to advancing equality across energy, housing and health:

A national climate change programme, which would enable us to invest in renewables, directly, employ a range of all of you, to be a skilled workforce

[WS6]

And a national retrofitting programme to decarbonise Wales's housing stock.... targeted at lower income homes who live in fuel poverty and many of whom are black, Asian and minority ethnic

[WS2]

We do have the National Health Service, and we do have an education system that isn't entirely privatised. But moving to direct employment is not the opposite direction from where government has been going in the last few years..it's green skills for all not just green jobs for some. We want green jobs or we want green skills for all, then it's Welsh government making that possible.

[WS4]

Drawing on reports that younger workers increasingly value employer's commitments to equality and sustainability [125] the panel argued that a National Climate Service offers a more coherent pathway to Net Zero than exiting employability initiatives, such as apprenticeships and youth guarantee programmes. They recommended a full scoping of the proposal, citing key challenges including the need to stimulate sufficient demand and build confidence within the education and training sectors. Crucially, the panel stressed the importance of a regulated training system, to prevent exploitative or 'cowboy' practices and ensure lessons are learnt from past failures:

We all know it takes some of us know that takes a while to develop an existing qualification via national occupational standards and also qualifications as well as commissioning new developments.

[WS3]

The panel questioned the effectiveness of the current education and training system in advancing Net Zero participation and equality, arguing that direct government oversight is essential to fostering more inclusive workplace cultures. In this context, it recommended adopting a social partnership and collective bargaining approach to embed the Welsh Government's Fair Work and national wellbeing goals – *legal obligations for public sector bodies in Wales, including the Welsh Government itself* [WS3]. By retaining strategic control over the education-employment nexus, the Welsh Government could lead a transformative shift: setting a standard for employers while addressing the uneven distribution of jobs and skills, particularly among minority and disadvantaged groups.

5. Concluding discussion: eco-equalities as a bridge between Net Zero and equalities to reinforce Just Transition

Our analysis identified three interlinked thematic priorities – the potential to adopt a more wide-ranging ecological ethos, scope to redefine Net Zero employment and the need for a more holistic programme of environmental upskilling - that reflect the evolving demands of a Just Transition and the potential for multiple, simultaneous pathways to equalities. These thematic priorities emerged from our equalities mainstreaming policy development model which was grounded in the perspectives of multiple equality organisations, policymakers, business and unions, along with our research efforts, to be consistent with a more socio-ecological approach that emphasises the multiple and diverse pathways to a Just Transition (Galcogzi; [90]). Struggles to address inequalities that are created by energy transitions and which marginalise workers have a long history [2]. Yet despite Net Zero's assertions of a just transition, its dominant imaginary is gender neutral, assuming that the opportunities to participate in and benefit from jobs and skills are equitable [7]. A focus on equality and the collective need to address Net Zero may have been viewed by some as a backward phase, because it seems to neither resolve existing inequalities across sectors, nor address what is regarded as the real threat to existing workers in fossil fuel industries. Still, the findings resolved that equality can be addressed at multiple levels, while remaining focused on efforts to build recognition of previously unseen groups and areas of concern, as summarised here:

Our research identifies the potential for the development of a deeper **ecological ethos** [106] which highlights the need to alleviate unfavourable cultures of work in existing Net Zero sectors - especially for marginalised groups - and a need to integrate non-technical skills and other knowledge in Net Zero skills policies. This theme recognised that while Net Zero is discursively 'new' and orientated to decarbonisation, the sectors that have been included often have existing workplace cultures and structures that marginalise certain groups, so that exclusionary practices persist and workforce diversification is limited. The panel argued that efforts aimed at redistributive justice are needed, but in this case, there is a need for an ecological focus that ensures that the experiences of those marginalised in existing roles and sectors are not overlooked. While approach limits itself to waged work within Net Zero, it represents a specific effort to not assume that environmental work is inherently more equitable.

Second, our study indicates scope for **redefining Net Zero** employment, which is complementary to an ecological ethos, but is aligned with a capabilities approach, and literature advocating for job re-design and revaluation. The panel appreciated that not only does Net Zero require new jobs and sectors, new skills and knowledges, and existing jobs needed in greater numbers, but that even sectors like energy do not yet appreciate the breadth of skills and knowledge required to support a Net Zero transition. From a feminist perspective, accounting for those sectors not automatically considered 'green jobs' has a transformative potential to build Net Zero strategies at scale. In a way that is inclusive of diverse skills and forms of work, it seeks to challenge the distinction between waged-productive and low/unpaid-reproductive work.

⁶ A National Nature Service for Wales.

Finally, the research findings reveal the need for a more holistic programme of **environmental upskilling** which centres on epistemic justice and a recognition of the rights of members of society to access climate knowledge and skills and so benefit from Net Zero and contribute to its intellectual and practical effects. From an economic perspective it represents a somewhat radical model of investment by government in areas that link education and renewables for the purposes of building a skilled local workforce to deliver on commitment to Net Zero participation and equity. At the same time, this effort aims to address inequality through these changing economic-political structures, by addressing the mean of inclusion to both Net Zero work and the wider sphere of green jobs..

Our first research objective was to consider how we might bridge the Net Zero and equalities literatures. In response and, based on our research findings, we have advanced the concept of **eco-equalities**, which demonstrates that is not just that simultaneous and intersecting pathways to equalities have been expressed [41] or that we can see alliances with other Just Transition efforts to remove barriers and reconcile injustice. Rather, it is the case that there are specific interrelated pathways to environmental equalities that understand the past social, economic, and even political harms borne by the communities, which take on a new set of environmentally-focused aims and goals when these communities are involved in policy planning about their futures [4,95]. In the efforts to ensure that environmental futures are less unequally distributed, Just Transition must not be the only rhetoric operating. Rather, **eco-equalities** provides for multiple principles and pathways to shape policy planning grounded in the futures of those most affected and generated from 'bottom up' experiences. This is subtly different from a Just Transition approach that rests on the finding that intransient inequality problems require alternative integrated ways of thinking. An **eco-equalities** approach considers that vulnerability, inclusion and representation are being constantly re-shaped by new environmental problems under capitalism, which play a big part in what policies are being created and adapted [34,46]. An **eco-equalities** emphasis, we argue, can help policymakers relate both to 'objective' changes to equalities (e.g. policies, actions, people) and to the subjective experiences of inequalities, while seeking to ensure that there is some attention to an 'ecological ethos' 'redefinition' of the environmental problem and 'environmental upskilling'. Furthermore, it is an approach that can assist in identifying the pragmatic approaches needed for remedying power inequalities that emerge from epistemic, distributive, procedural, recognition and capabilities processes.

Our second aim was to consider how we might better support policy-making and here we certainly see the value of equality mainstreaming, given the model's ability to incorporate public and equality expertise in policy development, and to change the way we think about addressing injustice for the most affected [36]. Our analysis is somewhat exploratory, but it does shed light on the ways that policy pathways to equality vary when the perceived roots of that inequality differ, particularly in the context of Net Zero. As a site for entrenched inequalities and new inequalities, the Net Zero context allowed us to consider just how highly diverse and contextual the understanding of equality is, as represented by the potential for a shift towards a wide-ranging ecological ethos, scope to redefine Net Zero and for a more holistic programme of environmental upskilling. In doing so, it represents the potential for a Just Transition to become fuzzier as it tries to respond to the scale and scope of equality, with all its contingencies, norms and assumptions.

Importantly, we note several limitations to our research. The equality mainstreaming model was originally designed on the basis of in-person deliberations and, given the timing of this research, we had to meet online which may have impacted the nature of relations between participants. There were occasions when substitute participants took part in the process, which may have caused a slight disruption and delay to the process, as originally designed. Finally, as might be expected, the process of the collective development of the three thematic priorities that emerged from the action research was characterised by lively

debate and discussion, and indeed sometimes tensions, between participants and viewpoints. Nevertheless, there was a remarkable consensus around the finalised priorities, even when these were subject to challenge from the researchers, with actors demonstrating a somewhat unified perspective about the absence of engagement and inclusion of marginalised and precarious citizens in Net Zero policymaking [41,91].

6. Concluding findings for energy and society

State-enabled reforms of employment in the energy sector aim to meet the needs of Net Zero policy and deliver a Just Transition but this research demonstrates that roots of inequality run deeper [36] and it is clear that we will need to mobilize new, intersecting processes to address both existing and emerging inequalities in Net Zero jobs and skills. Tomei [57] similarly calls for approaches that confront embedded, structural inequalities across sectors, occupations and communities. From our findings we drawn three key conclusions about eco-equalities as a framework for supporting equitable Net Zero skills development:

1. **Policy fragmentation:** Despite Just Transition goals to prioritise the most vulnerable [92], state efforts have largely focused on Net Zero sectors (including energy) inadvertently siloing employment and skills policy from fairness, inclusion and diversity. An eco-equalities perspective provides scope for energy system change by introducing dynamic localized forms of inequality that demand intersectional and innovative policymaking.
2. **Workplace Culture and Inclusion:** While workplace ethos is increasingly recognised in the energy sector, eco-equalities enables us to go further by redefining Net Zero employment to include not just *who* is involved, but *what* kinds of work are valued. This includes care work, education, and other under-recognised sectors. Environmental upskilling becomes a strategic recommendation: not just for energy security but for building a national climate service that integrates equality, training and employment.
3. **Urgency and Structural Change:** A major barrier to Just Transition is the slow integration of energy, skills and jobs policy, often constrained by a business-as-usual mindset [122]. An eco-equalities approach helps to identify more direct pathways to equality, aimed at structural, system-level change. Upskilling in this context will not just be technical but also transformational for the energy sector, requiring broad inclusion in workforce planning and a more socio-ecological orientation [4,57].

The work of building a truly inclusive energy workforce is far from complete. This paper advances an exploratory research approach and agenda that centres participation from groups – and specifically equality groups - historically excluded from policymaking processes [57]. Future research will be required so that we can continue to interrogate the economic and political shifts that produce new vulnerabilities and resistances to injustice in each new energy crisis, and to see if inequalities in the energy sector are addressed through the alternative equality frameworks proposed.

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CRediT authorship contribution statement

MacBride-Stewart Sara: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Parken Alison:** Writing – review & editing, Writing –

original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Ashworth Rachel**: Writing – review & editing, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Minto Rachel**: Writing – review & editing, Validation, Investigation, Data curation, Conceptualization.

Declaration of competing interest

Each of the research team has at time either completed contracted research for the Welsh Government and or sat as independent members of government panels. This research was initially funded as a Welsh Government Mainstreaming Equality Model Pilot Project. Contract Number: EM1. Neither the publication nor membership of committees represents a conflict of interest. All findings are independent.

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Appendix 1. Mainstreaming Equality and Just Transition Evidence Panel

Age Cymru
ARUP
Chwarae Teg
Office of the Children's Commissioner,
Disability Wales
Cytûn
Office of the Future Generations Commissioner
Institute of Welsh Affairs
Stonewall Cymru
Sustain Wales
Ethnic Minority Youth Support Team
Women's Equality Network
Welsh Government policymakers – 6 (inc. alternates)
Wales Trades Union Congress

Data availability

The data that has been used is confidential.

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