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Research Article

Managing gender-inclusive, just energy transitions in South Asia

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Abstract

The demand for a Just Transition (JT) is gaining momentum internationally and has important implications for the energy and power sectors. This paper draws on >10 years of practice integrating gender equality and social inclusion considerations in the energy and power sectors in low- and middle-income countries in South Asia and examines JTs in the energy and power sectors with a focus on gender equality. It includes a brief history of JT frameworks. The paper outlines the energy transition in South Asia, including progress towards net zero based on countries' Nationally Determined Contributions and some country strategies for integrating gender elements. It includes a brief energy audit that examines trends towards the incorporation of greater shares of renewables over the past two decades, the gender-related implications of distributed generation and demand-side participation, and the gender-related impacts on employment. Drawing on this landscape, the paper goes on to examine the transformation of the energy sector in the Maldives as a case study, with a focus on gender considerations, and draws out some key lessons for a gender-inclusive just energy transition (JET). The paper then proposes a gender and socially inclusive domains framework to guide policy and planning.

Lay Summary: A global energy transition is underway, which presents opportunities and challenges dependent on the technical and social context in which the transition takes place. Key to just transitions is the linkages between the energy transitions and gender equality and social inclusion. This paper investigates the transition from a fossil fuel-based economy to a clean energy future in South Asia and the implications for gender equality in the region. The energy sector transformation in the Maldives is examined as a case study of JET in the region and a domains-based framework is proposed to guide policy and planning.

Key words: energy; gender equality and social inclusion; just transition; distributed energy resources; Maldives; South Asia

Introduction

A just transition (JT) prioritizing equity, climate justice, and social inclusion is essential to enable ambitious mitigation actions and adaptation to address the worsening climate crisis driven by greenhouse gas (GHG) emissions, particularly from fossil fuel use [1]. The adverse impact of climate change is widespread and is unequally distributed across regions and within countries showing negative effects on gender and social equity. Rapid and far-reaching transitions and systemic change are therefore required [2]. South Asia's low- and middle-income countries, for instance, are the most prone to extreme heat waves in the world with the climate change impacts causing an increase in the severity and frequency of deadly extreme temperature events resulting in thousands of deaths in recent years, especially in urban slum areas with higher exposure to extreme heat [3]. South Asia is also heavily impacted by droughts in arid and semiarid areas, floods, and glacier melting in the Hindu Kush Himalaya region [4]. However, when one considers GHG emissions per capita indicators across regions, the indicators for Europe are three times greater than for South Asia; for Australia, Japan, and New Zealand, the indicator is five times greater; and for North America, it is over seven times greater than for South Asia [1].

Climate science also considers the fact that the high-income countries have a historical responsibility for excessive emissions since around 1850 and for usurping and depleting the global carbon budget by more than four-fifths, because of unsustainable lifestyles, production, consumption, and energy use, thereby constraining the options available for climate-resilient development for developing countries and regions, including South Asia [5]. The 'climate debt' of the Global North has been the basis of the campaign by the Global South for 'climate justice', especially with regards to financial support, critical for adaptation and mitigation measures in the Global South. The agreement by the Global North under the UNFCC and Paris Agreement to mobilize USD100 billion per year by 2020 never materialized.

Despite a gross domestic product (GDP) growth of 5.9%, one of the highest in the world [6], millions of people are trapped in poverty with worsening income inequality in South Asia. Around 400 million people are multidimensionally deprived (based on the multidimensional poverty index that takes account of education, health, and living standards), which is 80% of the total for Asia and Pacific. Although women have made gains in education, health, and financial access, nevertheless, structural barriers advancing gender equality persist [7].

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The energy transition to zero carbon systems must be accompanied by a careful assessment of their social and equity impact, particularly on low-income, vulnerable, and marginalized populations, to ensure that they do not exacerbate energy poverty or have other socially regressive effects. Beyond this, the objectives must be to improve and increase gender equality and social inclusion (GESI) outcomes from existing baselines. As our focus is the energy sector, we refer to this as a 'just energy transition' (JET); the process of transitioning from fossil fuel-based systems to sustainable systems based on renewable energy sources in a manner that prioritizes social equity, inclusivity, and environmental sustainability, so that all segments of society, particularly vulnerable and marginalized populations, are actively involved in and benefit from the energy transition.

Considerations of gender equity and social inclusions in JT literature have been mixed and piecemeal at best. A 2022 brief from the International Labor Organization (ILO) found that recognition of 'the gender dimension in green job opportunities and the inclusion of gender-specific policies within JT plans and strategies have yet to be realized on a wide scale'. This impacts on women's ability to access fair and decent work as labour markets shift [8]. There is still progress to be made to embed GESI considerations into JT initiatives. Ongoing advocacy is essential to ensure that the principles of a JT are applied as intended, or in a way that is beneficial to all members of society. Further it is crucial that women and other target groups are part of the co-design and implementation of any JT policies.

This paper aims to highlight the importance of GESI considerations as a key priority in JET. It is unique in that it places GESI considerations at the centre of JET. It presents a case study of the energy transition underway in the Maldives that incorporates GESI considerations and a domains-based framework or tool to guide policy and planning to support the systematic integration of GESI to enable JET. We draw from >10 years' practice in designing energy and power projects in South Asia integrating GESI. The objective of the paper is to examine the GESI implications of the energy transition and outline socio-technical approaches for integrating GESI into policies and plans.

The structure of the paper is as follows. Chapter 2 describes the methodology. Chapter 3 is a literature review outlining a brief history of JTs with a focus on concepts and definitions. Chapter 4 is an examination of the energy transition in South Asia. Chapter 5 presents the case study of the Maldives Preparing Outer Islands for Sustainable Renewable Energy Development (POISED) project as a useful example of JET. Chapter 6 draws from the previous sections and presents a GESI-inclusive domains-based framework to guide policy and planning. Chapter 7 highlights the key conclusions.

Methodology

The methodology of the study is informed by >10 years of experience in designing and implementing GESI-mainstreamed energy sector projects in South Asia, specifically Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka [9]. It draws from a combination of disciplines related to engineering, gender and development, and feminist studies, i.e. a multidisciplinary, GESI-centred, socio-technical approach. Our GESI-centred socio-technical approach is based on the following key elements:

a. Technology, its development, and innovation should enable and not prevent progress on GESI. This requires that GESI communities and groups are drawn into the processes by which technology is designed, developed, and used.

b. GESI communities and groups should be able to afford and access appropriate technologies and should not be excluded from doing so because of their gender.

c. An empowering environment should be created through policy, regulations, and standards-based solutions. [10]

Evaluation of social and economic consequences is important and should be monitored through appropriate metrics. The metrics should be standardized across the world and be accessible and reported on regularly to obtain insights and replicate successes [10]. Specifically, this paper is based on a literature review of JT concepts and definitions, drawing primarily from Asian Development Bank (ADB) gender and development approaches and ILO definitions, focusing on implications for labour, employment, and livelihoods in the JT.

Literature review and a brief history of just transitions

It is believed that the concept of JT emerged out of labour movements in North America [11]. The concept was used to advocate that new energy industries (including extractive industries) should develop in a way that protected workers' rights and created pathways for them to transition to employment in other sectors, whilst minimizing negative impacts on their communities [12]. Notably though, it often occupies the nexus between energy transitions and energy justice literature, as considering a JT away from coal has historically been a major focus [13]. This is reflected by the concentrated use of the concept in mining and energy transitions studies [14].

The analysis of JT from multiple academic disciplines has led to differing definitions and understandings of the concept [11]. Some use the concept as a framework to guide decarbonization in communities in high-carbon industries, whilst others focus on JT as a part of a transformative vision for societal change that would reduce injustices in our current social and economic systems [15]. To navigate the JT literature, scholars have commonly differentiated conceptualizations based upon 'the type of transition they argue for, the inclusivity of their scope and scale, their approach to participation, and the justice perspective they incorporate' [15].

Definitions of JT are varied. The ILO defines JT as a 'conceptual framework in which the labour movement captures the complexities of the transition towards a low-carbon and climate-resilient economy, highlighting public policy needs and aiming to maximize benefits and minimize hardships for workers and their communities in this transformation, and leaving no one behind [16]. Embedded in ILO's definition is that JT should minimize and mitigate any gendered impacts of the transition. The concept of JT has been taken up by many other international bodies and organizations. The ADB's definition, for example, is based on and aligned with ILO's definition. However, it goes further to state that, 'the management of potential negative impacts of climate action on people and societies; and ensures that prosperity brought on by the transition will be enjoyed by all' [17]. ADB's definition seeks not only to reduce inequities created by the transition but redistribute any 'gains'.

The 2015 Paris Agreement mentioned the importance of, 'a JT of a workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities' [18]. JT has also appeared repeatedly in World Bank documents, including a recent policy paper, 'Global Perspective on Coal Jobs and Managing Labour Transition out of Coal', which recognizes JT as one 'where costs and benefits are shared more equitably' [19].

Overall, whilst definitions differ, most focus on labour movements and supporting the energy transition.

It is important to note that JT literature often mentions different types of justice that occur due to the process and impacts of transition. Commonly, these include procedural justice, distributive justice, recognitional justice, and restorative justice [14]. Procedural justice means making sure all parties are continually and meaningfully consulted. Distributive justice means ensuring that the costs and benefits of the transition are shared. Recognitional justice recognizes that climate change and transition policies could exacerbate existing social inequities, and champions that all members of society should be treated as equals in the process. Lastly, restorative justice refers to the need to redress past harms and reduce the risk of future harm [14].

A recent systematic review on JT's meanings by [20] partly focused on the different 'types' of justice mentioned in the literature. Overall, they found that the literature predominately focused on distributional justice with less attention paid to recognitional and procedural justice [20]. However, whilst the importance of ensuring JT includes considerations of procedural, restorative, distributional, and recognitional justice, different justice scholarships overlay this literature.

JT, as a framework, brings together the academic areas of climate, energy, and environmental justice and are closely intertwined [21]. JT advocates for an equitable shift towards a more sustainable and low-carbon economy, with burdens and benefits distributed equitably. As Heffron describes it at their simplest, it's the application of a human rights perspective to 'climate justice' and 'energy justice', as well as 'environmental justice' based on the equality of all citizens and their involvement in the development of environmental laws, regulations, and policies and their implementation and enforcement [2]. To some extent, JT attempts to integrate these justice principles and emphasizes that a green transformation should decrease existing inequalities and promote fairness, inclusivity, and protect marginalized groups as we face environmental and climate change challenges. Heffron and others advocate for uniting these perspectives under the concept of 'JTs' [21]. JT as a concept has shifted from a labour-centred concept and broadened to focus on the importance of taking climate action in a way that is inclusive and protective of our most vulnerable communities.

Swarnakar, Singh, *et al*. introduce a unique grassroots perspective on a JT, with a focus on interviews with workers and community stakeholders in coal communities in India. They argue that 'the acceptance and legitimacy of the new changes must come from the people who are directly or indirectly dependent on the existing coal sector, as this workforce will be most acutely affected by the transition.' They emphasize the importance of managing and addressing the negative impacts on livelihoods and strengthening local governance to enable JT. [22]

Many countries have now included 'JTs' in their climate planning and commitment documents. According to the UNDP, 38% of countries have now embedded JT principles into their enhanced nationally determined contributions (NDCs), with others embedding them into their long-term strategies. The use of the principles is increasing. However, it remains unclear the contexts under which creating a 'JT' is possible and whether it is possible within existing societal systems and paradigms. Reviews have found that political contexts play a key role in forming the power dynamics and governance regimes of JT but are poorly understood [11]. Similarly, existing studies are largely focused on the Global North, with more research needed across a broader geographical context to illuminate how the success of JT policies differs in different regions [11]. Ultimately, contextual understanding of what makes JT successful remains understudied, particularly in conflict-prone and fragile states [23].

There are also some other obstacles to achieving JT. This is not surprising given the complexities of interacting social, economic, political, and environmental factors that must be addressed. Some of the major obstacles in the literature include: resistance from established industries, economic disparities, and widening inequalities in adapting to new economic structures; job displacement and retraining; having a lack of financial resources to make the transition smooth; lack of capacity to adapt to emerging technologies and green industries; political resistance and policy uncertainty, particularly argument around the urgency of addressing environmental issues; limited public awareness or insufficient public support; global economic interdependence and making sure new policies don't put less affluent and low- and middle-income countries at a relative economic disadvantage; inadequate infrastructure; short-term economic pressures to pursue short-term gains over long-term sustainability goals (economic rationalism); non-inclusive decision-making leading to social resistance; technological challenges; and geopolitical tensions whilst trying to cooperate to coordinate international responses to environmental challenges [12, 18, 23, 24]. Similarly, applying the concept of JT on the ground can be difficult given a lack of structure to guide the actors through the JT process [25]. This could impede the careful management of the JT process, especially in relation to inclusive planning and implementation, and could result in harmful impacts and unintended consequences. There are some leaders paving the way. In a recent paper, McCauley and Pettigrew *et al*. discuss some of the leaders and laggards in the EU JT space [26]. On balance, their analysis finds that countries in Scandinavia are leading the way in the region. Given their high uptake rate of renewable energy, they are consistently committing funds to green technologies and to focusing on social equality [26]. Due to their higher dependence on fossil fuels, Eastern Europe had fewer climate pledges and had created fewer 'fair jobs'. Their analysis saw the most varied performance across Western Europe, with many states having strong climate pledges whilst maintaining strong links to fossil fuel industries [26]. Further, in New Zealand, JT principles have been embedded into climate policies to make sure the engagement with indigenous communities is prioritized and become central voices of the transition.

There are also considerable initiatives underway in Asia. Just Energy Transition Partnerships (JET-P) have emerged as the mechanisms intended to support JT measures in Asia with the aim of phasing out coal-based power production. The partnership is between G7 countries and some of the major coal-producing countries in Asia, such as Indonesia. The government of Indonesia's JET-P is an initial investment of US$20 billion and has as its immediate objective the preparation of a Comprehensive Investment and Policy Plan (CIPP). The CIPP aims are ambitious, with targets to increase Indonesia's renewable energy generation share to 44% by 2030 and achievement of net zero emissions in the power sector by 2050. It's important to note that the CIPP incorporates 'principles and standards' to promote 'gender equality and empowerment of vulnerable stakeholders including women' [27].

India has not signed on to JET-P. According to some analysts, the terms are 'not attractive' as the public money on offer is inadequate to fund the transition to meeting India's renewable energy targets. They argue that India needs a different JET-P suited to India's agenda of expanding renewable energy, instead of the

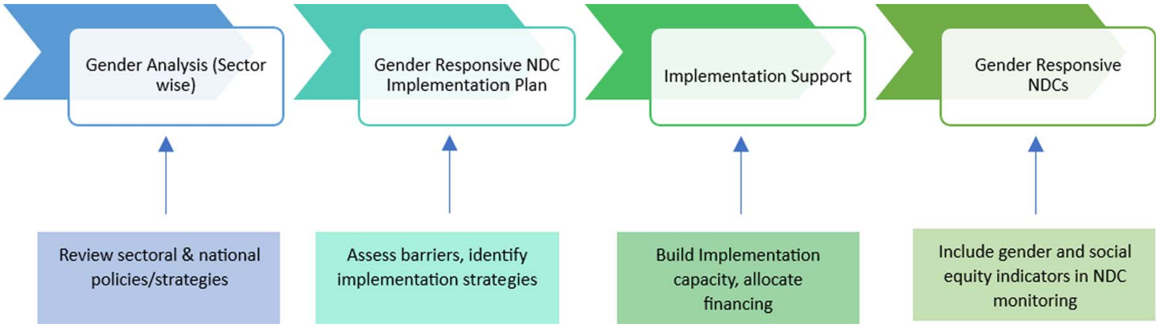

Figure 1. Approach to gender-inclusive NDC implementation. From [34].

focus being the phasing out of coal [28]. According to IRADe, India needs USD1494 billion in total aggregate investments, from 2020, to meet the country's net zero targets, which is an average of USD30 billion annually. The investment gap from 2020 until the net zero year is USD448 billion, and India will need investment support of USD179 billion, an average of USD4 billion annually [29].

Energy transition in South Asia

Progress on nationally determined contributions

A 2023 UN Economic and Social Commission for Asia and the Pacific (ESCAP) review of progress on JTs towards net zero in the Asia (including Bangladesh, Bhutan, India, Nepal, Maldives, and Sri Lanka) and Pacific regions found that for most countries, emissions under current NDCs will be higher than recommended levels for a 1.5°C pathway, and the pace of emission reduction resulting from NDC commitments is too slow to even contain global warming within 2.0°C warming. Moreover, the gap between the current and expected ambition levels in the region is widening. Even countries considered to be 'pace-setters', such as Bangladesh and Sri Lanka, have gaps between the NDC commitments and the 1.5°C pathway [30].

It is important to note, however, that India, one of the largest emitters in the Asia-Pacific, has achieved two of its 2015 NDC targets well ahead of time by reducing the emissions intensity of its GDP by 33% (the target was 33%–35% reduction by 2030 from 2005 levels) and has achieved 43.81% of the total cumulative electric power installed capacity from non-fossil fuel-based energy resources by October 31, 2023 (the target was to achieve ~40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030) [31] . India has updated and increased its NDC targets to reduce the emissions intensity of its GDP to 45% and the target on cumulative electric power installed capacity from non-fossil fuel-based energy resources to 50% by 2030 from 2005 levels [32].

On the integration of gender, however, there seems to be some progress with 37 out of 49 countries including gender elements in their NDCs, and out of the 24 countries that submitted updated NDCs since 2021, 19 countries have built on or added gender elements for the first time. Only a few, however, include comprehensive gender strategies [33].

Without comprehensive gender strategies, gender interventions cannot be implemented in practice. The Sri Lanka NDC, however, outlines some key elements of a gender strategy to guide implementation, as shown in Fig. 1.

Given that low-income women and vulnerable groups, such as indigenous communities, people with disability, and the elderly, are hardest hit by climate change impacts, meeting NDC targets and the funding support needed to achieve these targets are inextricably linked to achieving better than baseline GESI outcomes. Funding support is critical to enable a GESI-inclusive transition.

Dependency on fossil fuels

Whilst many South Asian countries have increased their share of renewables in electricity generation and have committed to increasing renewables in power generation in their NDCs, the dependency on fossil fuels remains and has even increased in some cases. There is a need to study this phenomenon to formulate policies and strategies that enable a more rapid shift to renewables.

The total primary energy consumption in the region (Bangladesh, Bhutan, India, Nepal, and Sri Lanka) increased by ~164% over the last two decades, driven by increasing population and growth in the manufacturing sector, and was slightly above the global average of 151%. India was in keeping with that average increase at a 161% increase in total consumption and generally in line with the increase in size of the country from a population of 1 billion to >1.4 billion. Bhutan recorded a significant increase in consumption of 334% followed by notable increases from Bangladesh and Nepal at 235% and 228%, respectively. Sri Lanka recorded the most modest increase in consumption over the two decades at 74%. [35]

In 2021, India's coal consumption increased again for the first time since 2018 and was up 7% compared with 2020 [36]. Electricity grid connections for the rural population and industrial growth is likely to contribute to continued coal consumption growth.

Figure 2 shows the electricity generation capacity of South Asia (Bangladesh, Bhutan, India, Nepal, and Sri Lanka) over the last two decades. Electrical energy production capacity in the region increased by a total of 425% across the two decades. Like the primary energy consumption trend, coal power capacity peaked in 2014/2015, but 'unlike' primary consumption, it consistently declined as a proportion of electrical capacity across the region until it reached 52.9% in 2021, in line with the significant uptake in renewable energy sources. [37]

India is, as expected, the dominant producer of power from coal. In 2000 it accounted for 62% of the country's capacity and by 2021 was down to 56.1% of capacity. It is the only country in the region that generates nuclear power, although Bangladesh does have a plant under construction. India has made progress towards the implementation of renewable energy sources—in 2000, renewables accounted for 27.7% of generation capacity, but by 2021, that had reached 37%. Solar is the dominant grid-interactive source at 49.1% of renewable capacity followed by wind at 36.7%. [38]

In Bangladesh, electricity supply jumped 640% between 2000 and 2020, and it is claimed by the Ministry of Power that 100% electrification was achieved in 2021. Most power sources in the

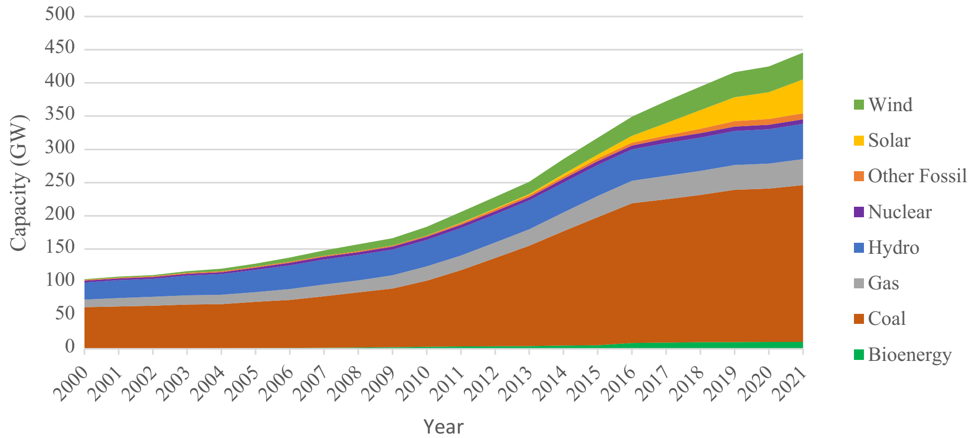

Figure 2. Electricity generation capacity in South Asia (Bangladesh, Bhutan, India, Nepal, Sri Lanka). From [37].

country are driven by natural gas, which amounts to 76% of the entire power supply. The country recently has problems with the local supply of natural gas and has been importing additional supplies to meet demand since 2018. The next biggest source of electrical energy in the country is from oil, which accounted for 6% of generated power in 2000, but by 2019 had risen significantly to 16%. The country does have some renewable generation capacity, making up 3.4% of the total. At the end of 2021, the country had 543 MW of solar capacity and 230 MW of hydro capacity. The country has also rolled out a significant rooftop solar photovoltaic (PV) programme (grid and non-grid connected), which accounted for 46.6 MW of capacity as of 2021. [39]

Nepal and Bhutan's power production capacity is overwhelmingly large-scale hydropower, much of it exported to India. In Nepal, total power production capacity has increased by 532% over the last two decades. Almost all local capacity is from renewable sources—92.5% is from hydro, 4.6% is from solar, and the remaining 2.3% is from non-renewable thermal power plants. As of 2022, the country also has a total solar–wind hybrid mini-grid system capable of producing up to 1500 kW of power. Nepal is exporting up to 452 MW of power to India from 10 hydropower projects, with plans to increase this up to 10 000 MW over the next 10 years. It is interesting to note that Nepal also relies on electricity imports from India, mostly during the dry season, which accounts for 15% of all available energy across the year. [40]

Generation capacity in Bhutan has increased by 568% over the last two decades. The country is overwhelmingly hydro-powered at 99.7% of all power generated. The remaining capacity is composed of 8.93 MW of diesel generators, 724 kW of solar power plants, and 600 kW of wind power plants. [41]

In the Maldives, power generation is largely distributed due to its geography of 1192 small islands. Of the 187 inhabited islands, only 12 of them have generation capacities >1 MW, whilst capacity in the rest of them ranges from 100 to 800 kW. This capacity is almost exclusively from diesel generators, and as of 2019, the Maldives had ~320 MW diesel generators of diesel-based generation capacity installed on inhabited islands and 210 MW on resort islands. The installed renewable generation capacity is much lower at only 16.5 MW of Solar PV. [42]

Distributed generation and demand-side participation

Distributed generation will play a key role in increasing renewable energy (RE) capacity. The International Energy Agency (IEA) predicts that India's rooftop solar PV, battery storage, electric mobility, and demand response are going to rise significantly over the coming decades under its various scenarios, with rooftop solar capacity reaching ~80 GW in 2030, and according to Bloomberg, the share of decentralized capacity in total installed capacity in India could reach ~25% by 2050 [43]. Distributed systems and mini-grids have been key to improving energy access, being smaller, more easily portable, and can reach underserved and remote areas. Distributed systems, dependent on multiple sources, are also more resilient than centralized, top-down generation systems to cope with the challenges of system failure at the high-voltage end [44]. Some studies find that off-grid systems, such as solar home systems (SHS), are a better option for meeting SDG7 targets compared to a grid extension scenario as they are cheaper, 'smarter' being flexible, reliable, faster to implement, especially for adaptations measures to build resilience, improve livelihoods, and develop sustainable local economies, and 'cleaner' options, with the potential to reduce GHG emissions [45].

The Bangladesh SHS programme is a well-known example, contributing significantly to providing electricity to 16% of the country's rural households, ~20 million people, between 2003 and 2018, which is estimated to be equivalent to using 4 billion litres of kerosene for lighting, emitting 9.6 million tCO_2. Social and gender benefits highlighted include benefits to education, greater safety and mobility for women with outdoor and indoor lighting, as well as reading and socializing. As a result of the programme, a local solar PV industry was established, including SHS retailers, service providers, finance companies, and manufacturers. [46]

In India, according to the Ministry of New and Renewable Energy (MNRE), the social and economic benefits of solar energy-based decentralized and distributed applications include a reduction in the time spent by rural women and girls in the collection of fuel wood from long distances, cleaner cooking, minimization of associated health risks, and has generated employment in villages. India's grid-connected solar rooftop capacity is ~11 GW and off-grid solar capacity is 2.7 GW, as of November 2023 [47]. In March 2022, the MNRE established a committee to promote 'women-centric policies, programmes, and interventions in the RE sector' [48]. Distributed generation can increase opportunities for the participation by women and other marginalized and excluded groups in the energy market; however, the question of who owns the technology is posed. A review of the Asia-Pacific Economic Cooperation (APEC) biogas programme in Nepal found a significant gap in biogas plant ownership by gender and caste [10].

Demand-side participation is expected to play a key role in the energy transition. As the share of renewables in the generation mix rises, greater flexibility in the electricity system is required to match supply with demand. Under the IEA's net zero by 2050 scenario, the share from fossil fuels is expected to drop to <5%, and battery storage and demand-side participation are expected to become the primary sources of flexibility at 44.6% of flexibility in emerging economies and 55.1% in advanced economies [49]. To develop demand-side response capabilities at this scale, not only does the grid need to be technically developed to deliver the appropriate signals, but initiatives that focus on consumer behaviour also need to be carefully implemented.

Power consumption behaviour at the residential level is affected by budget constraints as well as cultural norms. 'Active Shifting' refers to the management of energy consumption by shifting power usage according to signals from the supply side, usually concerning the cost of electricity. One way this could be achieved is through the automation of appliances controlled by a home system on behalf of a user that manages the time at which appliances are active by signals from the grid.

It is important to note that most tasks or chores related to the use of energy-consuming appliances, such as laundry, are performed by women who play a key role in household management, including household energy management. Feminists would argue that an analysis based on the examination of a gendered division of labour and energy consumption is necessary for effective Demand Side Participation (DSP), to improve the design and implementation of smart electricity systems [50].

One of the biggest benefits of the energy transition for developing economies is the increased health benefit. For instance, a significant proportion of South Asia's population do not have access to clean cooking options and rely on traditional biomass stoves for cooking, which produce gases and smoke that are harmful to human health. According to the World Health Organization (WHO), household air pollution was responsible for an estimated 3.2 million deaths per year in 2020, including >237 000 deaths of children under the age of 5. Women and children in low- to middle-income countries are disproportionately impacted as they typically labour over household chores such as cooking and collecting firewood and spend more time exposed to harmful smoke from polluting stoves and fuels. WHO defines fuels and technologies that are clean for health at the point of use as solar, electricity, biogas, liquefied petroleum gas (LPG), natural gas, alcohol fuels, as well as biomass stoves that meet the emission targets in the WHO Guidelines. Household air pollution is also a major contributor to ambient air pollution. [51]

According to a World Bank study, 9 out of 10 of the world's most polluted cities are found in South Asia. The study finds that the largest single reduction potential in air pollution is offered by universal access to clean cooking fuel (i.e. electricity and LPG), a low-cost option, which is also beneficial to saving the lives of poor women and children. [52]

Employment trends and prospects

Only 15% of those employed in the energy sector globally are women. It is estimated that women account for 22% of employees in the oil and gas industry and 32% of those in the renewable energy industry. In the Asia-Pacific region, it is estimated that 40% of all employees in the solar energy sector were women, which is in line with the global average. In administrative roles, women make up 50% of the balance, whereas in management the representation is lower at 30%. Interestingly, according to a survey from the International Renewable Energy Agency (IRENA), perceptions of gender barriers to entry to the solar industry were lower in Asia-Pacific than in the rest of the world. This may be due to the sheer number of jobs in the region in this industry—80% of all solar PV jobs worldwide are in the Asia-Pacific region [53]. The story for the wind energy sector in the Asia-Pacific is different, it is estimated that only 15% of those employed in the sector are women, as opposed to 21% globally. Women fill 12% of administrative roles and only 10% of management roles [54].

In South Asia, which has one of the lowest regional female labour force participation rates in the world and experienced the greatest decrease over the decade from 2009 to 2019, increasing women's participation in the energy sector is a daunting challenge [55]. According to the South Asia Women in Engineering and Power sector network (WePOWER), female representation in utilities is low (3%–25%) and even lower for women in technical roles (0.1%–21%). Most women in the South Asia energy sector tend to work in middle- to lower level non-technical administrative positions. Female enrolment in engineering is also low (0.5%–31%) [56]. Nevertheless, higher employment trends in the renewable energy sector indicate that the low-carbon energy transition provides an opportunity to address gender employment gaps in the energy sector. However, new policies are essential, incorporating strategies outlined here, to facilitate the adjustments in labour markets to maximize the opportunities for female participation in the sector.

Promoting women-led enterprises in emerging green industries will be critical to a GESI-inclusive energy transition, especially in micro and small enterprises (MSMEs). Given women's predominance in the informal sector, formalizing MSMEs in the informal sectors, such as waste management and recycling, will be necessary [8]. This needs to be combined with measures that increase women's access to new technologies to improve productivity, markets, training, low tariff rates, and regulations that incentivize innovation and entrepreneurship.

In India, where internal migrant workers are the backbone of the coal economy, the energy transition will have a significant impact on the lives and livelihoods of these vulnerable migrant communities. Many of these migrant workers are young people, contractual labourers not permanent workers, with little or no social security. They are on lower wages and contractors have no obligation to provide them with housing, healthcare, and other essential facilities. Many migrant labourers are seasonally employed and migrate with their families. In some cases, they are bonded labour. Many of them belong to the most vulnerable sections of Indian society, designated by the government as Scheduled Castes, Scheduled Tribes, and Other Backward Classes. These are extremely vulnerable communities that will lose their livelihoods by coal mine closures. Many of them have already been forced to migrate to other states looking for work. A JT must prioritize and give special attention to protecting these communities, from mitigating the impact on their lives and livelihoods, to taking the necessary measures to provide them with improved, secure, and sustainable employment and livelihoods in green industries [57].

In India, these green jobs are significantly confined to only a few states with above-average poverty levels. Wind power potential and future development capacities are concentrated in a handful of states in the Central West and South West regions, such as Tamil Nadu, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, and Karnataka. Solar PV is said to be more widely distributed. An energy transition could benefit some states, with losses for others, thus exacerbating the gaps between poor and more affluent states [58].

Maldives case study

Distributed energy resources and gender-inclusive community development

The Maldives is a small island state vulnerable to the impacts of climate change with its low-lying atoll islands threatened by rising sea levels [59]. The Maldives is highly dependent on imported fossil fuel as a primary source of energy. This makes the country very vulnerable to any adverse impact on fossil fuels in the international market. To reduce dependency on imported fossil fuels, increase energy security, and achieve its ambitious target of becoming carbon net-zero by 2030, the government is focusing its efforts in increasing the use of locally available renewable energy sources.

A significant transformation is taking place in the country's energy sector with the replacement of inefficient diesel generation sets with solar PV in the remote outer islands. The POISED project, established in 2014 and ongoing as of 2023, is the largest energy sector programme for the Maldives and is key to the energy transition underway in the country. The electricity consumption in the outer islands was approximately 390 GWh in 2022, which represents 41% of the electricity consumption for all inhabited islands (including the greater Malé region). As a result of project POISED interventions, ~12% of the outer islands' energy consumption (46 GWh) is being produced by solar PV energy. The long-term potential impacts of the project are expected to be an increase in renewable energy capacity and a reduction in the country's dependence on diesel-generated electricity, a reduction in GHG emissions, reduced electricity costs, and improved livelihoods for remote island communities with a focus on developing women-led microenterprises and thus contributing to women's economic empowerment. [60] Based on these considerations and potential impacts we assessed that the POISED project would be a useful and important case study of a GESI-inclusive JET.

The POISED project approved in 2014 was funded by the ADB, European Investment Bank (EIB), ADB Strategic Climate Fund (SCF), Japan Fund for Joint Crediting Mechanism, and the government of the Maldives. The ADB also mobilized additional funding assistance for the project in 2020. The project is implemented by the Maldives Ministry of Environment, Climate Change, and Technology (MOECCT), through the support from two energy utility companies servicing 187 inhabited islands: State Electric Company Limited (STELCO) and Fenaka Corporation Limited (FENAKA) [61].

Background

The Maldives comprises 1192 small islands, 187 of which were inhabited as of 2020, 79 were leased for agriculture and industrial activities, and 293 were assigned for tourism (159 registered as resorts and marinas). The estimated population in 2021 was 557 426 people, of which 227 000 live in Malé and 35 000 in Addu City (The estimated population includes foreign residents. The population of Malé includes inhabitants of Villingili and Hulhumalé). The rest of the populated islands are small, 27% of them with <500 inhabitants [62].

In 2020, Maldives emitted 1.99 million tonnes of CO_2 equivalent representing 0.00% of global emissions. The GHG emission per capita, however, was 3.69 tCO_2e per person in 2020, higher than the average for South Asia of 2.13 tCO_2e per capita and the highest in South Asia [63]. According to the Notre Global Adaptation Index, which considers vulnerability to climate change and related global challenges as well as resiliency and preparedness, the Maldives has a high vulnerability score of 0.53 in 2021 (where 0 is very vulnerable and 1 is least vulnerable) and is the 31st most vulnerable country with a score in the data base [64]. The country's human habitat vulnerability score, which captures a country's vulnerability of human living conditions to climate change, is 0.43 indicating a high level of vulnerability. Interestingly Maldives' infrastructure vulnerability score has a lower vulnerability at 0.63 [64]. However, the country has a high readiness score to respond effectively to climate change, although there is a greater need for adaptation and urgency to act [64].

The government's 2016 environment assessment report identifies climate change, energy security, solid waste management, and chemical management as 'key environmental issues' with 'sea level rise … a high threat' and 'the small size and low elevation of islands, settlements, and other infrastructure are subjected to high risk of inundation' (p 32). The report assesses that Maldives' dependency on imported petroleum products to meet all energy demands is 'making Maldives amongst the most energy-insecure countries in the world' (p 33) and solid waste management is a pressing environmental problem (p 34). According to the report, the limited freshwater resources make the Maldives 'highly water insecure' (p 31) [65].

The Maldives' Human Development Index (HDI) value for 2021 is 0.747— which puts the country in the high human development category—positioning it at 90 out of 191 countries and territories and is above the average of 0.632 for countries in South Asia. Between 1995 and 2021, Maldives' HDI value increased from 0.555 to 0.747, an increase of 34.6%. However, when the value is discounted for inequality, the HDI falls to 0.594, a loss of 20.5% due to inequality. The loss is especially high in the categories of education (29.3%) and income (25.8%). Gender gaps persist, with the female HDI value at 0.709 in contrast with 0.766 for males. Maldives has a Gender Inequality Index value of 0.348, ranking it 90 out of 191 countries in the 2021 index: only 4.6% of parliamentary seats are held by women; for every 100 000 live births, 53.0 women die from pregnancy-related causes; female participation in the labour market is 34.3% compared to 67.5 for men [66].

With respect to energy, the dispersion of the population and the small size of most islands have prevented the possibility of generating electricity centrally. Among inhabited islands, only 12 of them have generation capacities >1 MW, whilst capacity in the rest ranges from 100 to 800 kW. In 2019, the Maldives had ~320 MW diesel generators of diesel-based generation capacity installed on inhabited islands and 210 MW on resort islands [42]. Two energy utility companies service 160 inhabited islands: STELCO servicing the Greater Malé region and Fenaka Corporation Limited servicing the rest of the country. Energy services for the rest of the inhabited islands are run by local communities.

Fossil fuel imports account for 8%–10% of the GDP of the Maldives. The Maldives Customs Service's Total Imports 2019 estimates imports of 723 000 tonnes of fossil fuels (579 000 tonnes of diesel, 85 000 tonnes of petrol, 42 000 tonnes of aviation fuel, and 17 000 tonnes of LPG). About half of all the diesel imported is used for electricity generation in inhabited islands. Diesel is shipped in small quantities to the islands, involving costly and cumbersome logistics. Power systems are often oversized because of anticipated growth in demand. Consequently, these systems run at very low loads during off-peak hours, which results in poor fuel efficiency and higher maintenance costs. The generation costs are estimated to be in the range of $0.30/kilowatt-hour (kWh) in the most efficient power systems to $0.70/kWh in the smaller islands. This situation has led to government subsidies of ~1% of GDP in 2019 [67].

Maldives has significant renewable energy resources. The potential to generate solar PV power across the country is optimal [68], there is potential for wind power in some locations in the northern half of the country [69], and the potential for ocean tidal energy [70] and wave energy [71] is promising. Studies indicate the cost of energy generation from renewable energy-based hybrid systems would be lower than existing diesel systems.

The POISED project has mobilized nearly $129 million through grants and concessional loans to finance (solar PV–battery–diesel) hybrid systems, upgrade distribution networks, and provide technical assistance for regulatory reforms and capacity building for the MOECCT, Fenaka, and STELCO. The project is transforming the existing island grids through the introduction of renewable energy, combined with improved energy efficiency, thus significantly reducing the need for diesel to generate electricity.

Project design and implementation

The ADB provided technical assistance to recruit experts and conduct technical, environmental, and social assessment surveys during the project preparation and design stage. The GESI assessments were for the purpose of identifying key GESI considerations and to design interventions to improve GESI baselines, with a focus on gender equality. Consultations were carried out with key stakeholders and the island communities, including the Island Councils, Island Power Plant managers and staff, Women Development Councils, the public, and students and teachers.

Overall, the communities' perception was that the project was environmentally friendly and envisaged a reduction in noise and air pollution due to the reduced use of diesel. Although there were some concerns about disturbances to the community during project construction, they assessed that this would be temporary and outweighed by the long-term benefits of the project. The communities believed that the project would improve the quality of the service and hoped that it would reduce electricity costs. Waste management and the disposal of waste was a significant concern raised in most islands, due to limited space for storage [72].

A gender action plan (GAP) was prepared to integrate GESI in the project. Key GAP activities, indicators, and targets included at least 33% women's participation in public consultations, at least 25% local women trained and employed as technical and customer service officers for mini-grid systems, outreach programmes involving Grades 11 and 12 students with the aim, amongst others, of encouraging female students to take up engineering and technical training courses, investigating the possibility of reduced off-peak or shoulder-rate tariffs as incentives for women-led micro and small enterprises, and capacity development in GESI for the MOECCT, Fenaka, and STELCO. Resources were allocated, including the recruitment of social and gender and development experts, for the implementation of the GAP [73].

The POISED project aims at meeting a minimum of 70% percent of the daytime peak load demand in more than 160 islands in four phases, starting in 2014 and finishing in 2024–25. This includes the installation of energy management and control systems, increase in energy storage, and improvements in energy efficiency and distribution networks in all islands covered by the project. There are three categories for the architecture of the hybrid grids depending on the penetration of renewable energy in the islands: (1) moderate renewable energy penetration and 40% of peak load, with no energy storage; (2) high renewable energy penetration, 40% to 100% of peak load, and where battery storage provides grid-support services; and (3) very high renewable energy penetration, >100% of peak load, and battery storage that typically allows the system to operate 4–6 hours, with no diesel generation sets.

POISED targets aim to reach 30 MWp of solar PV, 12.5 megawatt-hours (MWh) of energy storage, and modern energy management systems fully commissioned in 160 outer islands by 2025. Additional financing processed by ADB in 2020 supports pilot initiatives including solar PV-based ice-making factories to support fisheries, and renewable energy-based passenger ferries to support marine transport. The POISED project has established a mechanism to collect and report operational data from each island for both operation and maintenance requirements and commercial and fuel-related usage data for subsidy payments. Other components of the POISED project include: (i) the preparation of a renewable energy road map to support the low-carbon transition development plan of the government; (ii) capacity building for stakeholders and communities in the outer islands; and (iii) supervisory trainings for FENAKA and STELCO to ensure the sustainability of the project.

To achieve reductions in diesel fuel consumption, new investments have been proposed. To assess the impact of these investments, five study scenarios have been defined: (i) Baseline, which considers only the existing genset; (ii) No PV or battery; a more efficient diesel genset with specific fuel consumption of 0.31 l/kWh (The diesel genset is operated with variable load depending on the PV penetration for each period. The average diesel generator fuel consumption is 0.31 l/kW. (iii) No battery energy storage systems (BESS), where the maximum PV power installed has been restricted to 15% of conventional diesel power (100 kW); (iv) Optimum, a PV penetration of 33.2% in energy terms, on the yearly balance, yields the minimum levelized cost of energy, and; (v) 100% PV, designed for a 100% PV penetration with the PV power plant and the BESS sized to supply the entire demand.

The industry standard HOMER software is used to calculate technical and economic parameters. The investment costs for the different technologies considered are 1000$/kWp for the PV power plants, 800$/kWh for the batteries, and 400$/kW for the diesel generators, the O&M costs are considered 1% of the investment cost. The results, Net Present Cost (NPC) and Levelized Cost of Energy (LCOE), for each case are shown in Fig. 3. The LCOE for Case 4 is 0.4$/kWh.

Figure 4 indicates the estimated reduction in electricity and carbon dioxide emissions for different PV penetration scenarios in Buruni island for the investments being considered. It indicates a substantial reduction in emissions for the optimum solution incorporating renewables and a small increase in electricity generation. The electricity demand in Buruni is being supplied by two diesel generators of 100-kW capacity each. They are highly inefficient, with a specific fuel consumption of 0.45 l/kWh.

Results

As of June 2023, the POISED project has installed or is culminating the installation of 24.5 MWp of solar PV, 8 MWh of BESS, 27 MW of energy-efficient diesel generators, and renewable energy-ready grids in 70 inhabited islands across eight atolls. The implementation of the POISED project has achieved fuel savings of 25% per hybrid system.

The gender-inclusive community outreach programme was implemented, targeting the Women Development Councils, to raise awareness on the benefits of renewable energy and household demand-side management to improve energy efficiency. Workshops were conducted with the Women Development Councils, NGOs, and female government officials. A total of

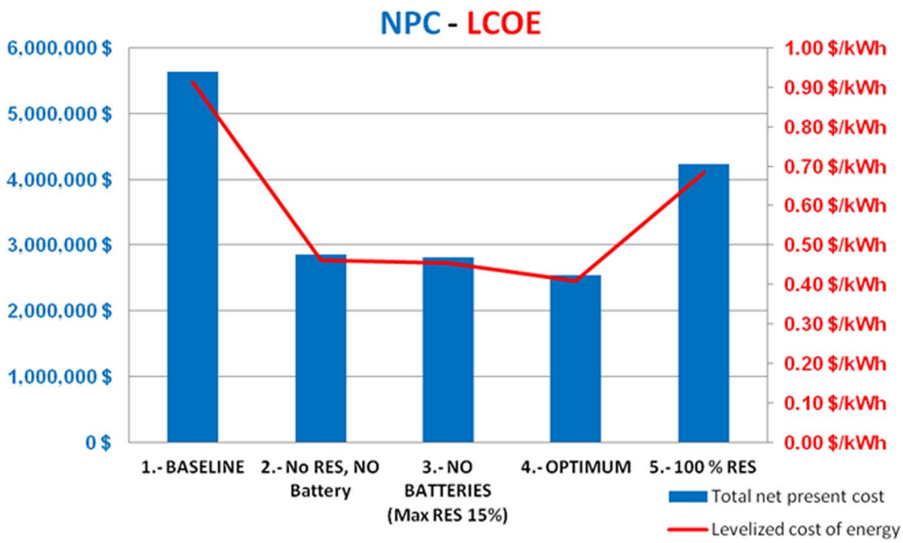

Figure 3. NPC and LCOE for five scenarios. From the POISED Project Management unit.

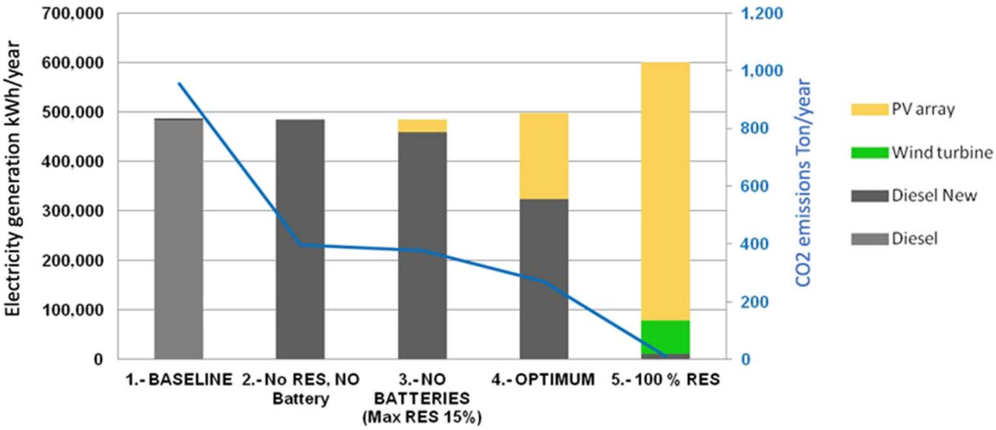

Figure 4. Identification of optimal generation mix based on LCOE and its estimated CO_2 emissions reduction in Buruni Island. From the POISED Project Management unit.

113 gender-inclusive community outreach programmes were implemented with >50% women's participation, exceeding the 33% target. Figure 5 is an awareness session on renewable energy and energy efficiency for the Women Development Committee in Felidhoo Island, Vaavu Atoll.

Career guidance on renewable energy studies in schools has been conducted for grades 8–12 on all 160 islands, and a total of 6800 students across 79 islands participated in these sessions [74]. Fenaka and STELCO trained and hired 1368 women utility officers to manage the systems. The POISED project has also conducted 49 training and information sessions on reducing tariffs, to off-peak or shoulder rates, for micro and small enterprises led by women.

Furthermore, ice-making factories on four islands are being installed under the project in partnership with the Women Development Councils to support the fishing industry, boost livelihoods, and to expand women's income-earning opportunities through community-based enterprises [75]. This will also potentially provide an alternative pathway to local economic development, other than tourism, and significantly reduce the dependency on the tourism industry [76].

The POISED programme has provided many valuable lessons for JET in the Maldives and in South Asia. These include:

- Raising public awareness on the benefits of renewable energy, which helped gain public support for the project.

Figure 5. Session on renewable energy and energy efficiency, the Women Development Committee, Felidhoo Island, Vaavu Atoll, March 2017. From the POISED Project Management unit.

- The importance of raising awareness about the linkages between the energy transition and GESI.

Figure 6. The JET domains framework. From Reihana Mohideen.

- Mobilizing women as a target group, in this instance the Women Development Councils, women's NGOs, and female government officials.
- Providing training and employment for women to enable them to utilize potential opportunities.
- Finding solutions to finance the project bodes well for the ability of the Maldives to raise funds. Because of the borrowing constraints as a small country, the Maldives was typically able to raise only small grants and loans. The POISED programme was able to mobilize larger funding, up to $129 million, through grants and concessional loans.
- Increasing the technical and overall capacity in the energy sector, including GESI awareness in the sector.
- The need for clear GESI policies, strategies, and plans to maximize the potential opportunities for GESI and these plans to be well resourced to enable effective implementation.
- Distributed generation may be more conducive to enabling women's participation and maximizing women's economic empowerment.

We think that these lessons are applicable to JET and JT in other countries, such as small island states in the Pacific. The project has been presented at various conferences and seminars with the aim of encouraging exchanges on the potential applicability of the project in other countries' contexts.

Drawing from the existing literature summarized above, the lessons drawn from the Maldives case study, as well as the experience as practitioners designing and implementing GESI strategies and plans in the energy sector in South Asia, we have identified the following domains to provide a framework to guide JET, particularly in relation to policy and planning. The eight domains identified are interconnected and interrelated.

1. Policies: Specific GESI policies should be in place to promote inclusive outcomes in JET. Coherent policies are needed across the economic, environmental, social, education, training, and labour portfolios. Policies should also enable enterprises and MSMEs, workers, investors, and consumers to participate and drive the transition towards environmentally sustainable and inclusive economies and societies. Subsidy reforms are also needed, informed by GESI considerations, such as the precarious nature of GESI communities, their low-income status and limited access to livelihood opportunities.

2. Access to key utilities and quality energy services by excluded and vulnerable groups in an integrated manner: income-poor, women, older people, persons with disability, disadvantaged ethnic groups and castes, those in vulnerable geographic locations, slum and transient populations, and marginalized due to their sexual orientation, gender identity, and gender expression.

3. Economic development: The growth of green industries and the promotion of sustainable practices can lead to the creation of new job opportunities and enterprises (MSMEs) and contribute to economic development. Maximizing GESI in access to these opportunities means addressing the gender gap in science, technology, engineering and mathematics (STEM) education, STEM industries, and closing the gender pay gap in STEM industries.

4. Employment and green jobs—reskilling and upskilling: Workers in carbon-intensive industries may require new skills and training to transition into green jobs. Governments, employers, and educational institutions play an important role in providing the necessary training and support. Social dialogue between governments, employers, trade unions, and civil society is essential to develop inclusive and effective strategies for JET and to address potential conflicts and challenges.

5. Social protection: The establishment of adequate social protection systems is essential to enable JET. Social protection systems need to provide income security and social services, based on international labour standards, to increase resilience and safeguard communities against the impacts of economic and environmental vulnerabilities and shocks.

6. Community-centred Local Governance: Vulnerable communities on the frontlines should be a part of the decision-making and leadership of their transition. This also involves the utilization of traditional, indigenous, and local knowledge; valuing of non-polluting care work as 'climate work'; application of integrated (community, district, subnational, and national levels and across industries and sectors), inclusive, and decentralized, community-based participatory approaches.

7. Technology innovation: Technology innovation presents promising opportunities for JET, such as distributed generation and demand-side participation in the power system and energy markets. The new challenges require socio-technical approaches for system design.

8. Financing: Funding mechanisms and arrangements to support GESI outcomes in JET must be ensured. Countries that commit to a GESI-inclusive JET can use their commitments to leverage international funding.

Figure 6 depicts a composite, integrated, and inclusive domains framework. This framework can be used as a tool to guide the integration of JET in energy transition policies and plans.

Conclusion

The technological transition needed to avoid climate change will by necessity mean significant changes to society, not just current systems of energy generation, but current systems of transport, housing, food production, entertainment, communication, clothes production, packaging, and distribution of things, which are all ecologically unsustainable.

The urgency required means that, unlike any previous technological transition in history, this energy transition will need to be deliberate and planned. Market forces can create technological innovation but without deliberate planning, such innovation can worsen the current climate crisis and exacerbate existing social inequalities including GESI. Whilst JT concepts and frameworks are starting to address GESI considerations, GESI is not adequately examined or systematically integrated. Where GESI activities are incorporated, resources are not provided for implementing these activities.

Addressing GESI considerations as a core aspect of JET is essential to pursuing a JT. A key consideration is to address GESI impacts, especially in communities transitioning out of coal, as well as opportunities in emerging green industries, in relation to employment, livelihoods, and economic empowerment of women and vulnerable communities. This is especially important in South Asia, which includes countries with some of the lowest female labour force participation rates in the world and a very high participation of women, young people, and other marginalized and vulnerable groups in the informal sector.

Deliberate planning in relation to GESI must be based on policies to enable a GESI-inclusive JET. This paper proposes a domain-based GESI framework as a tool to guide policy and planning. It proposes that specific GESI policies should be in place to promote inclusive outcomes in JET and that they need to be coherent across the economic, environmental, social, education, training, and labour portfolios. Effective planning also requires that the necessary resources are provided to support the implementation and monitoring of GESI strategies and plans. Evaluation of social and economic consequences is important and should be monitored through appropriate metrics, which should be standardized, accessible, and reported on regularly to obtain insights and replicate successes.

The Maldives case study of the POISED project demonstrates that the energy transition provides opportunities to improve GESI outcomes, especially in relation to women's economic empowerment, as well as affordability and reduction of GHG emissions, thus enhancing overall sustainability. In relation to GESI this requires deliberate and well-resourced strategies to be put in place to ensure that these opportunities are maximized. An additional consideration to note is that distributed generation may be more conducive to enabling better than baseline GESI outcomes.

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Author Contributions

Sithy Mohideen (Conceptualization [Lead], Methodology [Lead], Supervision [Lead], Writing—original draft [Lead], Writing—review & editing [Equal]), Jaimes Kolantharaj (Formal analysis [Equal], Investigation [Equal], Writing—review & editing [Equal]).

Conflict of Interest Statement

None declared.

The paper draws from the work of both authors in the energy sector in South Asia over several years.

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Data availability

The data underlying this paper are derived from sources in the public domain and are available in the list of references.

References

1. IPCC Climate change 2023: synthesis report. In: Core Writing Team, Lee H, Romero J, (eds.), *Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC, 2023, 35–115
2. Heffron RJ *Achieving a Just Transition to a Low-Carbon Economy*. Switzerland: Springer International Publishing, 2021
3. Li D, Yuan J, Kopp RE. Escalating global exposure to compound heat-humidity extremes with warming. *Environ Res Lett* 2020;**15**:064003. https://doi.org/10.1088/1748-9326/ab7d04
4. IPCC Climate change 2022: impacts, adaptation, and vulnerability. In: Pörtner H-O, Roberts DC, Tignor M *et al.*, (eds.), *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, NY, USA: Cambridge University Press. Cambridge University Press, 2022, 3056
5. Government of India Press Information Bureau, New Delhi, India. Ministry of Environment, Forest and Climate Change. India welcomes the IPCC working group II contribution to the IPCC sixth assessment report (AR6) on climate change: impacts. In: *Adaptation and Vulnerability*, 2022, Accessed at https://pib.gov.in/PressReleseDetailm.aspx?PRID=1801942
6. IMF, 2023. *World Economic Outlook (October 2023)*. Washington, D.C., USA: IMF. Accessed at: https://www.imf.org/external/datamapper/profile/SAQ
7. UNDP 2024 regional human development report. In: *Making Our Future*. New Directions for Human Development in Asia and the Pacific. New York: UNDP, 2024.
8. ILO. Just transition policy brief. *Gender Equality, Labor and a Just Transition for All* 2022; Available at https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_860569.pdf
9. Enhancing Gender Equality and Social Inclusion Results in South Asia Developing Member Countries. Available at https://www.adb.org/projects/54305-001/main
10. Mohideen R, Aberg A, Mareels I. DIITA-gender equality and social inclusion (GESI) workstream white paper - gender and technology: the case of the energy sector. *DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper - Gender and Technology: The Case of the Energy Sector* 2022;1–40
11. Wang X, Lo K. Just transition: a conceptual review. *Energy Res Soc Sci* 2021;**82**:102291. https://doi.org/10.1016/j.erss.2021.102291
12. Otlhogile M, Shirley R. The evolving just transition: definitions, context, and practical insights for Africa. *Environmental Research: Infrastructure and Sustainability* 2023;**3**:013001. https://doi.org/10.1088/2634-4505/ac9a69

13. Carley S, Konisky DM. The justice and equity implications of the clean energy transition. *Nat Energy* 2020;**5**:569–77
14. Abram S, Atkins E, Dietzel A *et al.* Just transition: a whole-systems approach to decarbonisation. *Clim Pol* 2022;**22**:1033–49
15. Johansson V. Just transition as an evolving concept in international climate law. *Journal of Environmental Law* 2023;**35**:229–49
16. Rosemberg A. Building a just transition: the linkages between climate change and employment - International Labour Organization. *International Journal of Labour Research* 2010;**2**: 125–61. https://labordoc.ilo.org/permalink/41ILO_INST/1s2ok2m/alma994615923402676
17. Hughes K, Rescalvo M Just transition beyond the energy sector. In: 0 ed., ADB Briefs, (ed.), ADB *Briefs Asian Development Bank*, Metro Manila, 2021
18. Intergovernmental Panel On Climate Change (IPCC) ed Accelerating the transition in the context of sustainable development. In: IPCC (ed.), *Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1st edn. Cambridge, United Kingdom: Cambridge University Press, 2023, 1727–90
19. Bulmer R, Pela EK, Eberhard-Ruiz A *et al. Global Perspective on Coal Jobs and Managing Labor Transition out of Coal: Key Issues and Policy Responses*. Washington DC: The World Bank Group, 2021
20. Stark A, Gale F, Murphy-Gregory H. Just transitions' meanings: a systematic review. *Soc Nat Resour* 2023;**36**:1277–97
21. McCauley D, Heffron R. Just transition: integrating climate, energy and environmental justice. *Energy Policy* 2018;**119**:1–7
22. Swarnakar P, Singh MK, Chatterjee R *What is Just Transition? Perception of Grassroots Stakeholders. Kanpur, Uttar Pradesh*. Kanpur, India: Just Transition Research Centre, Indian Institute of Technology Kanpur, IITK, 2022, 2–3
23. McCandless E, Onbargi FA. Just transitions and resilience in contexts of conflict and fragility: the need for a transformative approach. *Curr Opin Environ Sustain* 2023;**65**:101360. https://doi.org/10.1016/j.cosust.2023.101360
24. Wang Q, Zhang C, Li R. Impact of different geopolitical factors on the energy transition: the role of geopolitical threats, geopolitical acts, and geopolitical risks. *J Environ Manag* 2024;**352**:119962
25. Banerjee A, Schuitema G. How just are just transition plans? Perceptions of decarbonisation and low-carbon energy transitions among peat workers in Ireland—ScienceDirect. *Energy Res Soc Sci* 2022;**88**:102616
26. McCauley D, Pettigrew KA, Todd I *et al.* Leaders and laggards in the pursuit of an EU just transition. *Ecol Econ* 2023;**205**:107699. https://doi.org/10.1016/j.ecolecon.2022.107699
27. JETP Indonesia. *Just Energy Transition Partnership Indonesia, Comprehensive Investment Policy Plan 2023*. Jakarta: JETP Indonesia, 2023. Accessed at https://jetp-id.org/storage/official-jetp-cipp-2023-vshare_f_en-1700532655.pdf
28. Chandrashekhar V *Climate Home News, September 2023*. Why India is rebuffing a coal-to-clean deal with rich nations. Kent, United Kingdom: Climate Home News, 2023. Accessed at https://www.climatechangenews.com/2023/09/13/why-india-is-rebuffing-a-coal-to-clean-deal-with-rich-nations/
29. IRADe Integrated research and action for development, March 7, 2023. In: *Examining the Impact of Just Transition in India. ADBI Virtual Conference on Sustainable Finance for Asia's Net Zero Transition*. New Delhi, India: IRADe, 2023. Accessed online at https://www.adb.org/sites/default/files/event/854081/files/p8-adbi-coal-transition-rev.pdf
30. ESCAP, UNEP *et al.* United Nations, Economic and Social Commission for Asia and the Pacific, United Nations Environment Programme, International Labour Organization (ILO), the Regional Collaboration Center for Asia-Pacific of the secretariat of the United Nations framework convention on climate change (UNFCCC/RCC Asia-Pacific), United Nations Industrial Development Organization (UNIDO) (2023). In: *2023 Review of Climate Ambition in Asia and the Pacific: Just transition towards regional net-zero climate resilient development*. New York, USA: United Nations Publication, 2023
31. Government of India Press Information Bureau, 18th December 2023. Ministry of Environment, Forest and Climate Change. In: *India achieves two targets of Nationally Determined Contribution well ahead of the time*. New Delhi, India: PIB Fact Check Unit, 2023.
32. Government of India. *India's Updated First Nationally Determined Contribution Under Paris Agreement (2021–2030) August 2022 Submission to UNFCCC*. Delhi: Government of India, 2022. Accessed online via UNFCC at https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf
33. UN Women, 2023. Asia and the Pacific. Unpacking gender integration in nationally determined contributions (NDCs) of Asia-Pacific countries. Accessed online at https://asiapacific.unwomen.org/en/digital-library/publications/2023/11/unpacking-gender-integration-in-nationally-determined-contributions-ndcs-of-asia-pacific-countries.
34. Sri Lanka Ministry of Environment *23rd September, 2021. Submission of Amendment to the Updated Nationally Determinde Contribution of Sri Lanka*. Battaramulla: Sri Lanka Ministry of Environment, 2021, 53. Accessed through UNFCC, https://unfccc.int/sites/default/files/NDC/2022-06/Amendmend%20to%20the%20Updated%20Nationally%20Determined%20Contributions%20of%20Sri%20Lanka.pdf
35. EIA. *Online Database (Bangladesh, Bhutan, India, Nepal, Sri Lanka)*. Washington DC: EIA, 2021. Accessed online at: https://www.eia.gov/international/data/world/total-energy/total-energy-production
36. EIA. *Country Analysis Executive Summary, 17 November* 2022. Washington DC: EIA, 2022. Accessed online at https://www.eia.gov/international/content/analysis/countries_long/India/india.pdf
37. Ember. *Ember Electricity Data Explorer*. London: Ember, 2021. https://ember-climate.org/data/data-tools/data-explorer/ (accessed 12 December 2023)
38. Government of India, Ministry of Statistics and Programme Implementation, National Statistical Office *Energy Statistics India - 2023*. New Delhi: Government of India, 2023
39. Ministry of Power Energy and mineral resources Government of the People's Republic of Bangladesh. In: *Integrated Energy and Power Master Plan (IEPMP) 2023*. Dhaka: Government of the People's Republic of Bangladesh, 2023
40. Nepal Electricity Authority *A Year In Review – Fiscal Year 2022/2023*. Kathmandu: NEA, 2023
41. Bhutan Department of Energy Ministry of Energy and Natural Resources *Bhutan Energy Data Directory 2022*. Thimphu: Bhutan Ministry of Energy and Natural Resources, 2022
42. Government of Maldives, Ministry of Environment, Climate Change, and Technology *Island Electricity Data Book 2019*. Malè: Government of Maldives, 2019.
43. Poudineh R, Mukherjee M *et al.* Rahmatallah Poudineh, Mohua Mukherjee and Gabriela Elizondo and Gabriela Elizondo OIES. In: *2021. The Rise of Distributed Energy Resources: A Case Study of India's Power Market*. Oxford: Oxford Institute for Energy Studies, 2021
44. ADB. 2021 *Energy Policy of the Asian Development Bank Supporting Low-Carbon Transition in Asia and the Pacific*. June 2023. Metro Manila, Philippines: ADB, 2023. Accessed online at https://www.

adb.org/sites/default/files/institutional-document/737086/energy-policy-2021.pdf

45. Blechinger P, Köhler M, Juette C *et al. Off-Grid Renewable Energy for Climate Action – Pathways for Change, Published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*, December 2019. Germany: GIZ, Bonn and Eschborn, 2019
46. Cabraal, A., Ward, W.A., Bogach, V. S., ; Jain, A. 2021. *Living in the Light: The Bangladesh Solar Home Systems Story*. © World Bank, Washington, DC. http://hdl.handle.net/10986/35311 License: CC BY 3.0 IGO.
47. MNRE. *Programme/Scheme Wise Cumulative Physical Progress as on December, 2023*. New Delhi, India: MNRE, 2023. Accessed online https://mnre.gov.in/physical-progress/
48. MNRE *Office Memorandum, 8th March, 2022*. New Delhi, India: MNRE, 2022. Accessed online https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/01/2023012366.pdf
49. International Energy Agency *Net Zero by 2050: A Roadmap for the Global Energy Sector*. Paris: IEA, 2021
50. Johnson C. Is demand side response a woman's work? Domestic labour and electricity shifting in low income homes in the United Kingdom. *Energy Res Soc Sci* 2020;**68**:101558
51. WHO. *Household Air Pollution. 15th December, 2023*. Geneva, Switzerland: WHO, 2023. Accessed online at https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health
52. World Bank Group *Striving for Clean Air*. Washington DC; The World Bank Group, 2023
53. International Renewable Energy Agency (IRENA). *Solar PV: a Gender Perspective*. Abu Dhabi: IRENA, 2022
54. International Renewable Energy Agency (IRENA). *Wind Energy: A Gender Perspective*. Abu Dhabi: IRENA, 2022
55. World Bank Group *South Asia Regional Gender Action Plan (RGAP) II 2023–2028*. Washington DC: The World Bank Group, 2022
56. WePower. *The South Asia Women in Power Sector Professional Network*. Washington DC: The World Bank Group, 2021
57. Acharyya M, Swarnakar P *Just Transition: Labour Migration in Indian Coalfields*. The Just Transition Research Centre, Indian Institute of Technology Kanpur, 2023
58. Ordonez JA, Jakob M, Steckel JC *et al*. India's just energy transition: political economy challenges across states and regions. *Energy Policy* 2023;**179**:113621. https://doi.org/10.1016/j.enpol.2023.113621
59. World Bank, ADB. *Climate Risk Country Profile Maldives*. Washington DC, USA: World Bank Publications, 2021. Accessed online at https://www.adb.org/sites/default/files/publication/672361/climate-risk-country-profile-maldives.pdf
60. Climate Investment Funds *(December 20)*. *Preparing Outer Island Sustainable Electricity Development Project (POISED)*. News & Events, 2019, https://www.cif.org/news/preparing-outer-island-sustainable-electricity-development-project-poised
61. ADB. *A Brighter Future for Maldives Powered by Renewables: Road Map for the Energy Sector, 2020–2030*. Manila, Philippines: ADB, 2020. https://www.adb.org/sites/default/files/publication/654021/renewables-roadmap-energy-sector-maldives.pdf
62. Maldives National Bureau of Statistics Government of Maldives, Ministry of National Planning and Infrastructure, National Bureau of Statistics. 2021. In: *Statistical Pocketbook of Maldives, 2021*. Malé: Government of the Maldives, 2021
63. Climate Watch *GHG Emissions*. Washington, DC: Climate Watch, 2023. Accessed online at https://www.climatewatchdata.org/embed/ghg-emissions%3FbreakBy%3Dregions%26calculation%3DPER_CAPITA%26end_year%3D2020%26gases%3Dall-ghg%26regions%3DSAR%26start_year%3D1990
64. ND-GAIN, 2023. University of Notre Dame, ND-GAIN Notre Dame Global Adaptation Initiative, 2023. Accessed online at https://gain.nd.edu/
65. Ministry of Environment and Energy *State of the Environment 2016*. Malé: Ministry of Environment and Energy Republic of Maldives, 2016, Accessed online at https://www.environment.gov.mv/v2/wp-content/files/publications/20170202-pub-soe-2016.pdf
66. UNDP Human Development Reports. *Maldives. 8th September, 2022*. New York USA: UNDP, 2022. Accessed online at https://hdr.undp.org/data-center/specific-country-data#/countries/MDV
67. World Bank *Project Appraisal Document of the Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) Project, Report No: 145392-MV*. The World Bank Group, Washington, DC, 2020
68. World Bank. *Solar Resource and Photovoltaic Potential of the Maldives: Solar Resource Atlas*. Washington, DC: The World Bank Group, 2018
69. National Renewable Energy Laboratory. Wind energy resource atlas of Sri Lanka and Maldives. In: Purcell M, Gilbert T, (eds.), *2015. Wind Resource Mapping in Maldives: Mesoscale Wind Modeling Report*. Colorado: NREL, 2003
70. Centre for Understanding Sustainable Practice, Robert Gordon University *Pre-Feasibility Report on Scottish Support for Maldives Marine Energy Implementation*. Aberdeen: Marine Energy in Maldives, 2011
71. Contestabile P, Lauro ED, Galli P *et al*. Offshore wind and wave energy assessment around Malè and Magoodhoo Island (Maldives). *Sustain For* 2017;**9**:613
72. Initial Environmental Examination Thaa and Nunnu Atoll, POISED Phase 5 subproject, 2022 POISED Initial Environmental Examination Thaa and Nunnu Atoll, 2022. Accessible online at https://www.adb.org/sites/default/files/project-documents/46122/46122-005-iee-en.pdf
73. Gender Action Plan, ADB 2020. Accessed online at: https://www.adb.org/sites/default/files/project-documents/46122/46122-005-gap-en.pdf
74. Greening The Islands foundation. Accessed online at: http://www.greeningtheislands.net/index.php/nproject/winner-energy-2021_maldives/
75. Global Sustainable Electricity Partnership. Accessed online at: https://www.globalelectricity.org/projects/solar-ice-dhiffushi-maldives/
76. Ministry of Environment, Climate Change and Technology, Maldives. Accessed online at: https://www.facebook.com/environment.gov.mv/posts/pfbid02dgotKjTcNXtknKQfjxxjEUiQg2WrhZFvqUYEj87P3yvBM34QZQi7wisesyjdRvFtl