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Task Force 02

SUSTAINABLE CLIMATE ACTION AND INCLUSIVE JUST ENERGY TRANSITIONS

Decentralized Renewable Energy (DRE) Systems: A Pathway to Just Energy Transitions in Vulnerable Communities

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Abstract

As the world transitions towards 100% clean energy, addressing the needs of vulnerable communities is imperative. These communities, often in developing economies, disproportionately bear the brunt of fossil fuel reliance, lacking access to clean energy and facing severe socio-economic impacts. With approximately 620 million people lacking electricity access by 2030, decentralized renewable energy (DRE) systems, such as solar micro-grids and rooftop solar, offer affordable, reliable, and sustainable energy solutions, especially in remote and impoverished regions.

Implementation of DRE faces several challenges as centralized energy policies have led to significant public debt and economic disparity, with private diesel generators proliferating to fill the supply gap. It highlights the need for decentralized systems offering equitable and reliable electricity supply. Creating an 'ecosystem' for DRE integration is essential, involving tailored energy solutions, financing, skill development, and policy support.

Promoting DRE in vulnerable communities includes investing in housing energy efficiency, providing affordable financing, supporting local technology innovation, and skill development. It's essential to incorporate clean energy into broader economic recovery policies by creating jobs and improving business competitiveness through lower operating costs. For example, hybrid solar diesel microgrids could provide energy access and reduce fossil fuels dependency, optimize domestic resources, and create jobs.

For G20, promotion of DRE in vulnerable communities aligns with global efforts to combat climate change, reduce inequality, and foster economic development. By focusing on DRE, G20 can contribute to achieving universal electricity access, mitigating carbon emissions, and advancing socio-economic progress in marginalized areas. This aligns

with SDGs and Paris Agreement, offering a pathway to a more sustainable, equitable, and resilient global energy future.

Diagnosis of the Issue

1. Global energy landscape

1.1. Overview of current global energy challenges.

The global energy landscape is undergoing significant transformations due to a mix of technological advancements, geopolitical tensions, and a global push for sustainability. McKinsey's Global Energy Perspective 2023 provides a comprehensive demand outlook, examining long-term trends across various sectors, fuels, and geographies. It sketches a range of energy transition scenarios with global warming outcomes between 1.6°C to 2.9°C by 2100, depending on the pace of technological progress and policy enforcement. The demand for fossil fuels is expected to peak by 2030, with renewables such as solar and wind poised to dominate the energy mix by 2050. Investments in the energy sector are expected to align with GDP growth, reaching between $2 trillion and $3.2 trillion by 2040.

1.2 Energy inequality: Disparity in financial investments towards renewable energy infrastructure.

One of the main crucial disparities is about the financial investment to support clean technologies. In the last year, renewable capacity additions grew by 50% and clean energy investments increased by exceeding $1.7 trillion. Moreover, a significant gap remains in clean energy investments – although accounting for one-fifth of the global population, the Africa region attracts only 3% of global energy investment. This means that investment benefits only countries with low risk of investments.

Adopting renewable energy infrastructure allows communities to become prosumers, generating their own electricity and reducing energy access disparities. This model democratizes energy production, offers economic benefits through reduced costs and potential income, and enhances energy security. Supportive policies and programs are crucial to overcome initial investment costs and technological barriers, facilitating sustainable and equitable energy access.

1.3 Environmental concerns: Impact of traditional energy sources on climate change.

Environmental concerns are at the forefront of global energy challenges, particularly the impact of traditional energy sources on climate change. The burning of fossil fuels for energy is one of the largest sources of CO2 emissions, contributing significantly to global warming. This has led to an urgent need for a transition to more sustainable energy sources, such as renewables, to mitigate the environmental impacts. The Global Energy Perspective 2023 by McKinsey emphasizes the uncertain path ahead for the energy transition, with wide-ranging scenarios that include varying outcomes based on technological progress, geopolitical risks, and consumer behavior.

2. Challenges in current energy systems

2.1. Infrastructure limitations: The inadequacies of existing energy infrastructure hinder renewable integration.

Renewable energy from sources such as solar and wind is characterized by variability and intermittency which implies that power from these sources will fluctuate bases on sunshine or wind. Integration of renewables require a significant change in the flexibility of power systems. This supply side variability is further compounded by increasing variability in demand on account of changing consumption patterns, increasing urbanization and new sources of load such as electric vehicles (TERI 2021). High costs are associated with energy storage systems and infrastructure which integrate renewable energy to the grid.

2.2. Energy inequality: Disparities in energy access and the consequences for underprivileged areas.

The SDG7 Report states that 675 million[1] people lack access to electricity, while nearly 2.3 billion rely on traditional fuels for cooking (IEA 2023). This situation, often termed energy poverty, disproportionately affects those in lower-income brackets, impeding basic needs fulfillment and contributing to health and educational disadvantages (Lee and Yuan 2024; Kedia and Cholayil 2022; Zhang et al. 2021; Pan et al. 2021; Oum 2019). Studies also link energy poverty to reduced agricultural productivity in rural settings (Shi et al. 2022), with systematic reviews further affirming its adverse effects on health and education (Katoch et al. 2024).

2.3. Environmental degradation: Current energy practices contributing to environmental issues.

Energy systems are responsible for nearly 80% of global GHG emissions, with the energy supply sector alone contributing about 34% or 20 GtCO2-eq of net emissions (IPCC 2022). Key demand sectors such as industry, transport, and buildings add significantly to the total, contributing 24%, 15%, and 6% respectively (IPCC 2022). Environmental issues linked to energy include air and water pollution, greenhouse gas emissions, thermal pollution, and waste (Agbede et al. 2021; Bilgen 2014; EEA 2004). WHO reports that household air pollution led to approximately 3.2 million deaths in 2020,

[1] https://trackingsdg7.esmap.org/downloads

including over 237,000 children under five (WHO 2023). Combined, ambient and household air pollution cause 6.7 million premature deaths annually (WHO 2023).

Recommendations

1. Decentralized renewable energy (DRE) systems

1.1. Understanding DRE: Define DRE and its components, explaining how it differs from centralized systems.

DRE systems use renewable sources like solar and wind to offer scalable, local energy solutions distinct from centralized power grids. They're pivotal for decarbonization, enhancing renewable integration, and democratizing energy access by allowing consumers to produce and consume as needed. This approach improves energy access and resilience, underlined by the need for supportive policies (World Bank 2022; IEA 2022).

1.2. Benefits for vulnerable communities: Illustrate how DRE can address specific challenges faced by these communities.

DRE systems enhance energy access in vulnerable communities, fostering development across SDGs related to health, education, and gender equality. By providing localized energy solutions, DRE supports vital services and development in remote areas. It improves food security by boosting crop yields and reducing post-harvest losses, benefiting rural livelihoods and farmers. DRE also promotes job creation and income generation, particularly for small business holder women and MSMEs, by offering reliable and affordable energy. To increase investments in DRE, innovative financial tools and de-risking strategies are essential, including blended finance and carbon finance solutions. Identifying bankable local projects is key to attracting investors and strengthening the sector's appeal.

1.3. Technological viability: Advancements in DRE technologies.

From 2010 to 2021, the DRE sector attracted over USD 3 billion in investments for standalone systems and mini-grids, signaling a promising increase in energy access by 2030. This growth is propelled by advancements in DRE technologies, including AI, IoT, and blockchain, which enhance energy planning, smart grids, and facilitate new trading models like PAYG and P2P. Such innovations are pivotal in improving renewable energy and battery storage technologies, offering a cost-effective route to decarbonization and sustainable development. Additionally, digital transformation in the sector has led to a surge in grid-related digital technology investments, improving energy efficiency, data transparency, and reducing investment risks in remote areas.

2. Policy recommendations

2.1. Policy frameworks for DRE: Proposing regulatory support for DRE adoption.

Renewables now make up about one-seventh of the world's primary energy and nearly one-third of the global electricity mix, highlighting a shift towards cleaner energy. This transformation emphasizes the need for strong policy frameworks to support and accelerate the adoption of DRE technologies. Effective policies should facilitate renewable energy integration into existing infrastructure, fostering innovation and investment. Tailoring these frameworks to local needs, especially in vulnerable communities, is crucial to spreading renewable energy's benefits widely.

2.2. Legislative incentives: Tax breaks, subsidies, and feed-in tariffs.

In 2020, renewable energy usage saw a 3% increase, contrasting with the decline in demand for other fuels, underpinned by nearly 7% growth in electricity generation from renewables. This was facilitated by long-term contracts, priority grid access, and ongoing installations of new plants, underscoring the impact of legislative incentives like tax breaks, subsidies, and feed-in tariffs. By 2021, renewable electricity generation was expected to rise over 8%, marking the most significant annual growth since the 1970s. These incentives are crucial for reducing initial costs and providing stable financial returns, thereby enhancing the attractiveness and financial feasibility of renewable energy projects.

2.3. Standardization and quality assurance: Ensuring reliability and interoperability of DRE systems.

Standardization and quality assurance are essential for ensuring the reliability and interoperability of DRE systems. Standardization involves developing and implementing technical standards that DRE systems must meet, ensuring that they are compatible with existing energy systems and with each other. This can facilitate the integration of diverse renewable energy sources into a coherent and efficient energy system. Quality assurance mechanisms, such as certification programs and regular inspections, can help maintain high standards of safety, performance, and reliability for DRE technologies. This not only protects consumers but also builds trust in renewable energy technologies, further promoting their adoption.

2.4. Financial mechanisms and investments: Enhancing the economic feasibility of DRE.

High interest rates and short repayment terms are major financial barriers to scaling up Decentralized Renewable Energy (DRE) systems in developing countries. Public resources should be used for interest subvention and grants to attract private finance.

Blended finance, de-risking, carbon finance, and public-private partnerships are crucial to build a supportive ecosystem for DRE investments.

2.4.1 Microfinance and grants: Tailored financial products for small-scale DRE projects.

Markets in developing countries have a bias towards diesel gensets because of a well established and supportive eco system. Typically the rates of interest for DRE in developing countries especially in Africa, range between 24 to 36 percent, with pay back periods of 8 to 12 months. In order to create a semblance of a level playing field for DRE applications especially for productive use, financial incentives need to be focused on interest subvention and back ended capital grants that provide positive impetus to banks and micro finance institutions to on lend for these applications.

2.4.2 Public-Private partnerships: Leveraging resources and expertise from both sectors.

Financial incentives to introduce new technologies and applications are effective if they are well embedded in the Government policy objectives and are provided as a programmatic incentive over a period of 5-7 years to build the required eco- system in a country, rather than as a stand alone incentive. This effectively implies building public and private partnerships to not only assess requirements from both demand and supply side, but to create the eco-system supportive of DRE and use financial incentives to address gaps in off take.

2.5 Capacity building and community engagement: Empowering local stakeholders.

2.5.1 Education and training programs: Building local expertise in DRE technologies.

DRE applications need to be designed keeping in mind local conditions and requirement of sophistication/complexity in operations. One area where these get overdesigned , with adverse implication on costs, is battery autonomy. DRE technologies need to be de- mystified by involving local technical institutions in designing curriculum and training. Practical and hands on training has shown to be more effective for both service providers and entrepreneurs. Exposure visits for entrepreneurs and bankers have yielded better uptake and confidence levels.

2.5.2 Community ownership models: Encouraging local management and ownership of DRE projects.

Existing collectives of either farmers, producers or women groups are the best entry point for DRE applications, which are enablers of enhanced productivity. Layering these applications on existing collectives offers a better chance for success. Energy is an enabler and the community capability, which already exists for a production process, needs to be harnessed, to introduce these solutions. Substituting a diesel based grids being operated by an entrepreneur or community with a solar based micro grid or replacing community operated diesel post harvesting equipment with solar powered ones, are more likely to provide early success and increase rate of uptake.

Scenario of outcomes

1. Positive impacts of DRE adoption: Envisioning the benefits of implementing the recommendations.

    1.1. Enhanced energy access: Improved electricity supply in remote areas.

Rural regions globally struggle with electricity access; urban areas see a 98% access rate versus 85% in rural zones[2]. In least developed countries, access was just 56% in 2021. Challenges include inadequate infrastructure, particularly in isolated areas, as well as the limited accessibility of financial resources to facilitate the development of the DRE market. Decentralized renewable energy (DRE) offers a viable solution, promising faster implementation and reduced losses, needing less investment to achieve comprehensive access. Forecasts suggest DRE could lower costs significantly, up to 30% for low-demand and 5% for high-demand scenarios, bridging the energy gap and fostering socio-economic growth in remote communities.

    1.2. Economic development: Job creation and stimulation of local economies.

The "Renewable Energy and Jobs: Annual Review 2023," in collaboration with the ILO, reports 13.7 million global jobs in renewable energy. The DRE sector's resilience is demonstrated by the fact that during the pandemic, the job impact was less severe as compared to other sectors particularly utility level RE. Despite economic challenges and a pandemic-induced employment dip, the DRE sector in India maintained over 80,000

[2] https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2023-full_report.pdf

jobs by 2021 as compared to other RE sectors[3]. Projects like IIT-Kanpur's rural pilot demonstrate DRE's potential to boost local economies through micro-grids and cottage industries, fostering job creation, entrepreneurship, and sustainable development.

2. Socio-economic benefits.

2.1 Potential impacts on local economies and livelihoods.

By 2030, more than 71% of new electricity connections will be via off-grid or mini-grid solutions, according to IEA (UN HLPF 2019, 3). DRE systems hold promise for empowering local regenerative economies in multiple ways. DRE projects can generate local green jobs in installation, maintenance, and management that benefit the youth, women, vulnerable communities and even MSMEs to improve inclusiveness (Chowdhury et al. 2016). Also, DRE can leapfrog the fossil fuel phase, reducing dependence on centralized grids and unstable fossil fuel prices and increasing energy security. Furthermore, DRE systems can improve agricultural productivity by providing power for irrigation and other applications (Chowdhury et. al 2009).

2.2. Relevance to G20 agenda: Aligning DRE with global economic and environmental goals.

DRE systems (under SDG7) are pivotal to the G20's sustainability, economic empowerment, and climate goals by leveraging sustainable resources to enhance energy access and reduce GHG emissions. They support the G20's sustainable development goals, energy security, and Paris Agreement commitments, promoting a resilient and

3 https://www.powerforall.org/application/files/6816/6425/3802/Powering-Jobs-Census-2022-India-3.pdf

inclusive economy. By diversifying energy sources and fostering local resilience, DRE advances energy security, mitigates emissions, and drives economic growth through job creation, marking a strategic shift towards a low-carbon, green energy future and overall, just transition.

2.3. Climate action: DRE's role in mitigating climate change.

Fossil fuel-based energy sources, by definition, rely on the combustion of coal, oil, or natural gas to generate electricity. This combustion process releases significant GHGs into the atmosphere, contributing to climate change. In contrast, DRE systems generate electricity from renewables, including sunlight and wind power (Venema and Rehman 2007). With due consideration of supply chain issues, the conversion of these renewables into electricity produces minimal emissions (Chowdhury 2003). This distinction makes DRE a critical component in the fight against climate change.

3. Challenges and trade-offs: Acknowledging potential obstacles and compromises.

3.1. Initial costs and investment risks: Addressing financial barriers to DRE implementation.

Financial barriers significantly impact the adoption of DRE in regions like India and sub-Saharan Africa, where many depend on agriculture for their income[4]. In India, where nearly half the population is engaged in agriculture with an average annual income of just US$1,490, the limited purchasing power restricts DRE technology uptake[5]. Sub-Saharan

[4] http://www.indiaenvironmentportal.org.in/files/file/decentralised%20renewable%20energy%20india.pdf

[5] Ibid.

Africa faces similar challenges with low Gross National Income per capita, affecting access to affordable credit[6] and perpetuating low productivity cycles. Despite increasing entrepreneurship in renewable energy, funding remains scarce, particularly due to investors' limited understanding of green business models outside software ventures[7].

3.2. Technological and infrastructural limitations: Overcoming physical and technical constraints.

Tackling DRE deployment challenges involves addressing technical hurdles, skill shortages, and financial barriers[8, 9]. Effective solutions include adapting technologies to local needs, enhancing skills through targeted training, ensuring spare parts availability, and facilitating access to affordable credit. [10] The variability of renewable energy and technical issues like complex designs and maintenance difficulties also need addressing. Strategic measures, such as comprehensive training programs, resource assessment improvements[11], and design standardization, are vital for the sustainable adoption of DRE technologies. [12]

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[6] Ibid.

[7] Ibid.

[8] https://doi.org/10.1016/j.rser.2015.12.224

[9] https://india-re-navigator.com/public/uploads/1645592374-CLEAN%20Network,%20CEEW_State-of-the-Decentralized-Renewable-Energy-Sector-in-India_Feb%202022.pdf

[10] Ibid.

[11] https://doi.org/10.1016/j.rser.2015.12.224

[12] Ibid.

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