



ENVIRONMENTAL POLITICS SERIES

ENERGY TRANSITION IN YEMEN: A PATH TO JUSTICE AND SUSTAINABLE DEVELOPMENT

*Abeer Al-Eryani
Musaed Aklan*



Arab
Reform
Initiative



مركز صنعاء للدراسات الاستراتيجية

Published by:

Arab Reform Initiative

The Arab Reform Initiative is an independent Arab think tank working with expert partners in the Middle East and North Africa and beyond to articulate a home-grown agenda for democratic change and social justice. It conducts research and policy analysis and provides a platform for inspirational voices based on the principles of diversity, impartiality, and gender equality.

<https://www.arab-reform.net/>

Sana'a Center Strategic Studies

The Sana'a Center for Strategic Studies is an independent think-tank that seeks to foster change through knowledge production, with a focus on Yemen and the surrounding region. The Center's publications and programs, offered in both Arabic and English, cover political, social, economic and security-related developments, aiming to impact policy locally, regionally, and internationally.

<https://sanaacenter.org/>

About the authors

Abeer Al-Eryani is a postdoctoral fellow at the Center for Environment, Community, and Equity at the American University in Washington, D.C. Her research focuses on how wars, crises, and institutional disruptions impact energy systems, with a particular emphasis on energy transitions, justice, and the political economy of conflict. She investigates who benefits from or suffers due to these changes and how they affect the development of equitable and conflict-sensitive energy pathways.

Musaed Aklan is a Senior Researcher at the Sana'a Center for Strategic Studies focused on water, the environment, and climate change. He holds a Master's in Integrated Water Resources Management from Cologne University in Germany, and a double PhD in Water Resources Management from IHE-Delft and Wageningen University in the Netherlands. He has worked with INGOs and international institutions as a lead researcher and consultant in the field of water and the environment.

About the study

This policy brief was prepared by the Sana'a Center for Strategic Studies in partnership with the Arab Reform Initiative as part of the SIDA-funded project "Strengthening Civil Society Actors and Networks Advocating for a Just Environmental Transition in the Middle East and North Africa"

Disclaimer:

The information and views set out in this report are those of the author(s) and do not necessarily reflect the views of the Arab Reform Initiative, its staff, its board or its funders.



© 2025 Arab Reform Initiative.

This license allows re-users to distribute, remix, adapt, and build upon the material in any medium or format for non-commercial purposes only, and only so long as attribution is given to the creator. If you remix, adapt, or build upon the material, you must license the modified material under identical terms.

Cover photo: Yemen. Local workers inspect rooftop solar panels in a mountain village, part of community efforts to secure sustainable off-grid electricity.

© Adel Alsharaee / Anadolu Agency

November 2025

This paper was produced with funding from the European Commission and the Swedish International Development Cooperation Agency



Civil Society Facility for the Mediterranean
مرفق المجتمع المدني
لمنطقة المتوسط



Table of Contents

Executive Summary	6
Introduction	7
1. The Energy Transition Landscape	8
1.1 Climate Commitments	8
1.2 Energy Sector Outlook	9
1.2.1 The Growth of Solar PV	11
1.2.2 Current Energy Policy Frameworks in Yemen	12
2. Toward a Just and Conflict-Sensitive Energy Transition in Yemen	13
2.1 Policy Gaps	15
3. Current Opportunities and Future Pathways	16
3.1 Grassroots Developments	16
3.2 Rural Electrification as a Peace Dividend	18
4. Conclusion	19
5. Recommendations	19
Strategic Areas of Action	19
Stakeholder-Specific Recommendations	21

Executive Summary

Yemen's energy sector is currently facing a severe crisis. For millions of Yemenis, accessing reliable electricity is a daily struggle, characterized by prolonged blackouts, limited fuel supplies, and deteriorating infrastructure, which in turn exacerbate the country's humanitarian conditions. This policy brief underscores the importance of a just and conflict-sensitive energy transition in Yemen, addressing the interconnected challenges of conflict, economic instability, and energy poverty. It emphasizes the urgent need for an energy transition that enhances energy access, promotes decarbonization, and supports peace building and socio-economic recovery.

The brief outlines the current energy landscape in Yemen, identifies critical policy gaps, and highlights both top-down and grassroots opportunities for sustainable energy development. It acknowledges the significant challenges in the energy sector, including its fragmentation, weak institutional capacity, and limited resources, further compounded by the lack of coordinated governance structures since the war, and the rise of multiple centers of power, including the internationally recognized government, the Houthi group (Ansar Allah), and other armed groups.

Despite these challenges, the study identifies key opportunities for transformative action, particularly at the community and local levels. Experience in Yemen shows that interventions in rural areas encounter fewer technical, political, and financial challenges.¹ Rural areas are remote from power and influence centers, are home to the majority of the country's population, and are largely disconnected from public energy networks. They also offer a more conducive environment for piloting energy projects compared to urban centers, providing successful examples that help build momentum for broader reform.

To guide Yemen's energy transition, the development of a comprehensive, evidence-based framework is essential. This framework should prioritize components such as equitable access to energy, institutional capacity, and economic recovery, all of which should be analyzed through a conflict-sensitive lens. It must also ensure meaningful participation from marginalized groups, particularly women and youth, in both policy and implementation processes.

Realizing these objectives will also require coordinated action from multiple actors. The government should reform energy subsidies in a phased and socially sensitive manner, while creating incentives for decentralized and community-led energy projects. International and regional partners should adopt flexible and conflict-sensitive funding mechanisms and promote energy as a tool for peace building by supporting collaboration across conflict divides. Civil society actors, meanwhile, can play a vital role by facilitating community participation and raising public awareness on energy-climate-justice issues, with a strong emphasis on the needs and voices of rural populations. Finally, the private sector should actively engage in developing technical standards and aligning business models with conflict-sensitive approaches that enhance equitable access for underserved and remote communities.

¹ John M. Cohen et al., "Development from Below: Local Development Associations in the Yemen Arab Republic," *World Development* 9, no. 11 (1981): 1039–61, [https://doi.org/10.1016/0305-750X\(81\)90019-X](https://doi.org/10.1016/0305-750X(81)90019-X); Benoit Challand and Joshua Rogers, "The Political Economy of Local Governance in Yemen: Past and Present," *Contemporary Arab Affairs* 13, no. 4 (2020): 45–69, <https://doi.org/10.1525/caa.2020.13.4.45>.

Introduction

The Paris Agreement, adopted in 2015, set the goal of limiting global temperature rise to 1.5 degrees Celsius above pre-industrial levels. Numerous countries, including Yemen,² endorsed this agreement, committing to Nationally Determined Contributions (NDCs) aimed at reducing global carbon emissions. It was not until the 2022 United Nations Climate Change Conference (COP27), held in Sharm El-Sheikh, Egypt, that the concept of a “just transition” was explicitly incorporated into the final declaration, highlighting the need to balance climate action with social and economic equity.³ At the subsequent COP28, hosted by the United Arab Emirates in December 2023, the focus shifted toward the urgency of climate action. The final declaration emphasized the urgent need to transition away from fossil fuels and ensure a just, orderly, and equitable transition to sustainable energy systems.⁴

The Intergovernmental Panel on Climate Change defines a just transition as “a set of principles, processes, and practices that aim to ensure that no people, workers, places, sectors, countries, or regions are left behind in the transition from a high-carbon to a low-carbon economy.”⁵ Across the globe, countries are faced with the challenge of achieving an energy transition that addresses two critical challenges: climate change and economic development.⁶

Achieving a just environmental transition in conflict-affected or fragile settings, such as Yemen, demands approaches that balance urgent needs with long-term justice and sustainability. Key guiding principles include inclusive and participatory governance⁷ that ensures all stakeholders, especially marginalized and conflict-affected groups, are involved in decision-making;⁸ equitable distribution of both the benefits and burdens of transition;⁹ conflict-sensitive resource mobilization, such as redirecting international and climate funding toward green sectors while addressing systemic inequalities; decentralized renewable energy systems; and adaptable policies sensitive to local dynamics.¹⁰ Strengthening institutions and legal frameworks, addressing harms from past wars and mismanagement, and empowering local communities¹¹ are fundamental principles that should guide policymakers and practitioners aiming to steer environmental transitions toward equity and stability in the world’s most challenging contexts.

Against this backdrop, this policy brief marks an initial step toward developing a comprehensive

2 Yemen signed the Paris Agreement in September 2016 but has not ratified it, a requisite step to make it legally binding under national law. See: <https://unfccc.int/node/91445>

3 “COP27 Reaches Breakthrough Agreement on New ‘Loss and Damage’ Fund for Vulnerable Countries,” UN Climate Change News, November 20, 2022, <https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries>

4 “COP28 Agreement Signals ‘Beginning of the End’ of the Fossil Fuel Era,” UN Climate Change News, December 13, 2023, <https://unfccc.int/news/cop28-agreement-signals-beginning-of-the-end-of-the-fossil-fuel-era>

5 Qaraman Hasan, Raphael J. Heffron, Soran Mohtadi, Brian D. Blankenship, Indra Overland, Johannes Urpelainen, “Stepping into the just transition journey: The energy transition in petrostates,” Energy Research & Social Science, Volume 113 (July 2024), p.2, <https://doi.org/10.1016/j.erss.2024.103553>

6 Xinxin Wang and Kevin Lo, “Just Transition: A Conceptual Review,” Energy Research & Social Science, Volume 82 (December 2021), <https://doi.org/10.1016/j.erss.2021.102291>

7 In the current context of conflict and political fragmentation in Yemen, the entry point of participatory governance could be through local councils and organizations, civil society, private sector actors, and others.

8 “What Do Just Energy Transition Processes Look Like in Practice? Five Case Studies from Asia and South America,” Just Energy Transition in Coal Regions Knowledge Hub, International Institute for Sustainable Development, August 16, 2024, <https://www.jetknowledge.org/insights/giz-what-do-just-energy-transition-processes-look-like-in-practice-five-case-studies-asia-south-america/>

9 “Just Transitions: Conceptual Tools for Policy Reflection,” Netherlands Environmental Assessment Agency, Report no. 5599, December 11, 2024, <https://www.pbl.nl/system/files/document/2024-12/pbl-2024-just-transitions-conceptual-tools-for-policy-reflection-5599.pdf>

10 “What Do Just Energy Transition Processes Look Like in Practice? Five Case Studies from Asia and South America,” Just Energy Transition in Coal Regions Knowledge Hub, International Institute for Sustainable Development, August 16, 2024, <https://www.jetknowledge.org/insights/giz-what-do-just-energy-transition-processes-look-like-in-practice-five-case-studies-asia-south-america/>

11 “Green Economy: Just Transitions in Fragile States – The Case of Ukraine,” Beyond Group Impact Blog, February 3, 2025, <https://beyond-groupconsulting.com/impact-blog/green-economy-in-ukraine>

framework for Yemen’s energy transition. Grounded in equity, decentralization, multi-sectoral integration, and participatory decision-making, the proposed approach aims to address critical policy gaps and establish the conceptual and analytical foundations for a broader, collaborative effort to support the creation of a just and conflict-sensitive energy transition framework that is applicable at both the policy and grassroots levels.

The brief draws on a multi-method qualitative research approach. The analysis is informed by primary data collected through key informant interviews (KIIs), focus group discussions,¹² and outcomes from the third Yemen International Forum.¹³ It also incorporates a range of secondary sources, including official and policy documents, conflict datasets, economic indicators, and energy sector statistics. The researchers have additionally reviewed existing governance frameworks, drawing on data from sources such as the Green Climate Fund (GCF) Readiness and Preparatory Support Program, International Renewable Energy Agency (IRENA) reports, the Ministry of Electricity and Energy, and the UN.

1. The Energy Transition Landscape

1.1 Climate Commitments

Yemen is a signatory to the Paris Agreement and, in 2015, submitted its Intended Nationally Determined Contribution (INDC),¹⁴ outlining its commitments to mitigating greenhouse gas (GHG) emissions and adapting to climate change. The INDC set a modest goal of reducing GHG emissions by 14 percent below the Business-As-Usual scenario by 2030, with only 1

percent being unconditional and the remaining 13 percent contingent on international financial and technical support.¹⁵

Yemen’s overall contribution to global emissions remains limited, accounting for less than 0.1 percent¹⁶ of global GHG emissions, which has further decreased as a result of halted economic activity since 2011. The UN defines it as one of the 44 Least Developed Countries (LDCs) globally. However, Yemen’s mitigation strategy focuses primarily on expanding renewable energy, improving energy efficiency, and reducing emissions in transport, industry, and waste management sectors. The emission reduction target for the energy sector is set at 23 percent, as outlined in the Second National Communication.¹⁷

Since 2015, Yemen has made only minimal updates to its Nationally Determined Contributions (NDC). It has yet to develop or submit a formal National Adaptation Plan (NAP). It continues to rely on its 2009 National Adaptation Program of Action (NAPA) as the foundational document for climate adaptation planning. The NAPA was intended as an initial, iterative framework to address climate vulnerabilities and inform future adaptation strategies, as well as the comprehensive National Adaptation Plan. Despite minor changes in recent years, progress toward a formal, comprehensive NAP continues to be hindered by conflict.¹⁸

The 2009 NAPA identifies seven key areas of vulnerability: agriculture, water resources, coastal communities, biodiversity, coastal environments, infrastructure, health, and tourism. Projects

12 Based on the Yemen Energy Charter and insights from key informant interviews (KIIs) conducted as part of this study between November 2024 and June 2025.

13 “Yemen International Forum 2025 Report: Dialogue for a Stable Yemen and a Secure Region,” Sana’a Center for Strategic Studies, August 4, 2025, <https://sanaacenter.org/publications/main-publications/25152>

14 “Intended Nationally Determined Contribution (INDC) under the UNFCCC,” Republic of Yemen, November 21, 2015, <https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Yemen/1/Yemen%20INDC%2021%20Nov.%202015.pdf>

15 “Intended Nationally Determined Contribution (INDC) under the UNFCCC,” Republic of Yemen, November 21, 2015, <https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Yemen/1/Yemen%20INDC%2021%20Nov.%202015.pdf>

16 Crippa, M., D. Guizzardi, F. Pagani, M. Banja, M. Muntean, E. Schaaf, W. Becker, F. Monforti-Ferrario, R. Quadrelli, A. Riquez Martín, P. Taghavi-Moharamli, J. Köykkä, G. Grassi, S. Rossi, J. Brandão De Melo, D. Oom, A. Branco, J. San-Miguel, and E. Vignati, “GHG Emissions of All World Countries,” Luxembourg: Publications Office of the European Union, 2023, https://edgar.jrc.ec.europa.eu/report_2023?vis=co-2tot#emissions_table

17 “Yemen. National Communication (NC),” United Nations Framework Convention on Climate Change, accessed February 7, 2025, <https://unfccc.int/documents/145124>

18 “Readiness Proposal for the Republic of Yemen with UNDP,” Green Climate Fund, April 15, 2025, <https://www.greenclimate.fund/sites/default/files/document/readiness-proposal-national-adaptation-plan-yemen.pdf>

under the NAPA are assessed based on several criteria, including their contribution to sustainable development, enhancement of livelihood security for local communities, poverty alleviation to build adaptive capacity, alignment with other multilateral environmental agreements, and cost-effectiveness.

Although Yemen has not published a formal National Adaptation Plan, it has implemented some measures and strategies to address climate-related vulnerabilities, despite the challenges posed by the ongoing conflict. This includes developing the Climate Finance Country Program (CFCP)¹⁹ with multilateral technical assistance in 2024. The primary goal of the CFCP is to enhance Yemen's ability to mobilize climate finance, aiming to strengthen institutional and governance capacities to manage and utilize these resources effectively

The plan expands the priorities outlined in the 2009 NAPA, now explicitly including energy as a key area of focus. This marks a significant advancement toward developing comprehensive and context-specific policies, recognizing the role of energy in addressing the larger environmental challenges in Yemen.²⁰

1.2 Energy Sector Outlook

Yemen's power industry is currently witnessing the worst crisis in the nation's history. A review of Yemen's electricity sector in 2020, based on statistics from the Yemeni Public Power Company, estimated a national power generation gap exceeding 2444 MW, with an electricity demand of 3102 MW and an available supply of only 658 MW.²¹ This severe shortage has led to widespread load shedding and daily blackouts lasting between 15 and 20 hours in urban areas nationwide. Some regions, notably rural areas, are experiencing complete power outages. Other sources report that, as of 2021, generated

capacity ranged between 970 and 1,187 megawatts (MW), still significantly below the estimated national demand. Beyond underscoring the persistent capacity gap, these discrepancies also highlight a broader issue: fragmented and unreliable data infrastructure, a challenge this report identifies as a critical area for intervention.

The transmission network is fragmented and has inadequate transformer capacity, with only 2,087 megavolt-amperes (MVA) available despite a demand of 4,450 MVA. The distribution networks are overburdened and poorly maintained, resulting in further inefficiencies and reliability issues.²² Since 2015, large segments of the national grid have remained nonfunctional, resulting in a severe decline in operational capacity.²³ Losses in the transmission system now exceed 40 percent, ranking among the highest in the region. These losses are attributed to both technical and non-technical factors, including outdated and damaged infrastructure, a highly centralized and vertically integrated system, as well as electricity theft and administrative inefficiencies. Chronic fuel shortages and insufficient generation capacity further undermine the reliability of the power supply.

In terms of energy trends, total energy consumption in Yemen peaked in 2010 at 224,174 TJ, but then experienced a significant decline, dropping to 100,773 TJ by 2020, illustrating the severe impact of the ongoing conflict on the country's economy and energy infrastructure. Historically, the residential sector experienced a consistent rise from 13,710 TJ in 1990 to 55,070 TJ in 2010, driven by increasing domestic energy demand. As shown below (Figure 1), it declined post-2010 to approximately 38,257 TJ by 2020.

19 "Yemen Country Programme," Green Climate Fund, October 14, 2024, <https://www.greenclimate.fund/sites/default/files/document/yemen-country-programme.pdf>

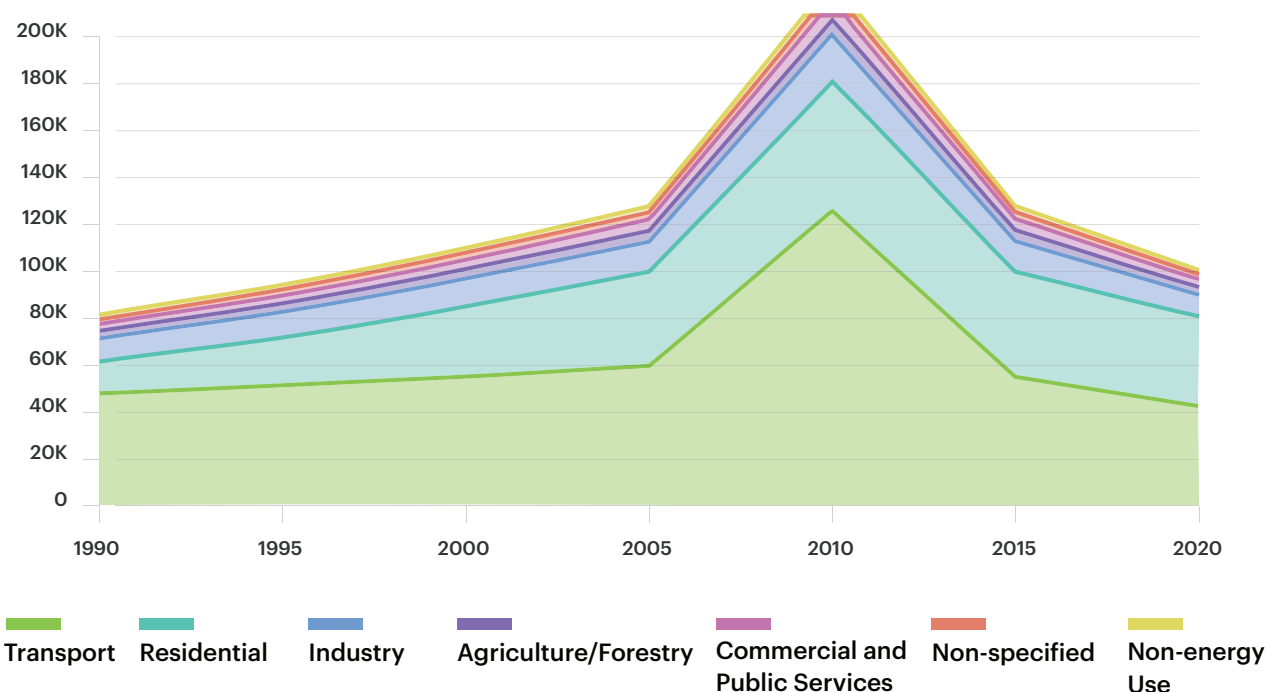
20 MUSAED AKLAN and HELEN LACKNER, "Solar-Powered Irrigation in Yemen: Opportunities, Challenges and Policies," Sana'a Center for Strategic Studies, April 29, 2021, <https://sanaacenter.org/publications/main-publications/13849>

21 AL-WESABI, I., ZHIJIAN, F., BOSAH, C.P. et al, "A review of Yemen's current energy situation, challenges, strategies, and prospects for using renewable energy systems," Environmental Science and Pollution Research, 29, 53907–53933, June 21, 2022, <https://doi.org/10.1007/s11356-022-21369-6>

22 Ibid.

23 NEIL MCCULLUGH et al., "Improving Electricity Services in Yemen," International Growth Centre, November 24, 2021, <https://www.theigc.org/publications/improving-electricity-services-yemen>

Figure 1: Yemen Final Energy Consumption Per Sector 1990-2020 (TJ) (Source: Yemen CFCP, 2024)



The weak state of Yemen’s energy sector is due to decades of underinvestment, mismanagement, and, more recently, prolonged conflict. Before the war, efforts to expand electricity access had increased national electrification rates to approximately 45 percent, though coverage was already one of the lowest in the MENA region.²⁴ Yemen has one of the world’s lowest per capita electricity consumption rates, at just 243 kWh per year.²⁵

Before the conflict, Yemen’s power generation relied primarily on natural gas (33 percent), heavy fuel oil (23 percent), and diesel (28 percent).²⁶ Since 2015, this mix has shifted almost entirely to diesel and heavy fuel oil.²⁷ The combination of infrastructure destruction, fuel shortages, and financial instability has left more than half of the

population disconnected from the national grid, while those still connected experience frequent and prolonged blackouts, with serious consequences for health and well-being, particularly among coastal populations.

During the war, the private sector has played an increasingly significant role in Yemen’s energy sector, stepping in to salvage or adapt parts of the collapsed public electricity infrastructure and facilitating the import and deployment of solar energy, thereby helping to meet the population’s essential energy needs. By 2023, over 70 percent of households with access to electricity were relying on some form of solar energy, with an estimated total installed solar capacity reaching approximately 300 MW between 2016 and 2018, primarily through private installations. In parallel, private providers supported water and agriculture sectors; studies reveal that more than 31 percent of Sana’a Basin farmers transitioned from diesel to solar-powered pumps.²⁸ This expansion in solar

24 “Yemen Emergency Electricity Access Project,” World Bank, last modified April 13, 2018, <https://www.worldbank.org/en/country/yemen/brief/yemen-emergency-electricity-access-project>.

25 Ibid.

26 Based on the Yemen Energy Charter and insights from key informant interviews (KIIs) conducted as part of this study between November 2024 and June 2025.

27 Derived from triangulated data sources and key informant interviews.

28 MUSAED AKLAN and HELEN LACKNER, “Solar-Powered Irrigation in Yemen: Opportunities, Challenges and Policies,” Sana’a Center for Strategic Studies, 2023.

technology through the private sector covered the energy needs for hundreds of thousands, but it also raised costs for vulnerable families and exacerbated inequality in energy service quality.²⁹

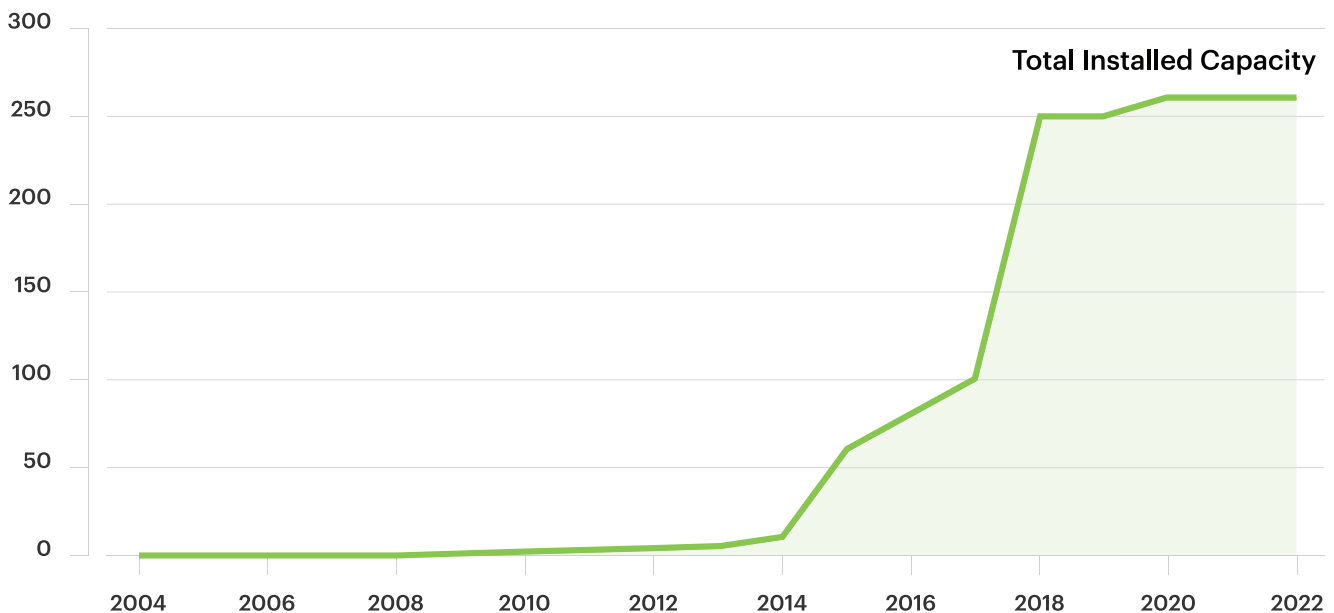
1.2.1 The Growth of Solar PV

As the public grid has deteriorated due to war, Yemen has experienced a notable increase in the adoption of solar energy technology (SHS). These include solar home systems (SHS), solar water heaters, Pico systems,³⁰ and solar-powered irrigation systems. Obtaining data on the total installed power in Yemen remains very challenging. However, conservative estimates suggest that total installed solar PV

capacity ranges from around 256 MW, according to IRENA estimates in 2022 (Figure 2), to more informal forecast of around 500 MW³¹ Notably, until the 120 MW Aden solar park was added in 2024, which is not included in the 2022 data (Figure 2), this capacity consisted entirely of off-grid systems.

The capacity of individual off-grid systems varies. Residential home systems range from 20 Wp to 2 kWp, while irrigation pumps range from 18.5 kWp to 26 kWp.³² Nonetheless, the scale of the diffusion has been unprecedented, and its implications are felt across society.

Figure 2: Installed Solar PV Capacity in MW (Source: IRENA-International Energy Agency³³ Country Profile Data)



gic Studies, April 29, 2021, <https://sanaacenter.org/publications/main-publications/13849>

29 “Despite its continuous outages... Yemen has the highest electricity tariff in the world [AR],” Yemen Voice, August 13, 2023, <https://ye-voice.com/news187303.html>

30 A pico solar system is a small, often portable, stand-alone photovoltaic (PV) system designed to provide basic electricity for lighting and charging low-power electronic devices.

31 Dawud Ansari, C. Kemfert, and Hashem al-Kuhlani, “Yemen’s Solar Revolution: Developments, Challenges, Opportunities,” EADP, February 2019, <https://www.semanticscholar.org/paper/Yemen%E2%80%99s-solar-revolution%3A-Developments%2C-challenges%2C-Ansari-Kemfert/7b88ee5e95dad0f17619fc20af9816cb9254bc6c>.

32 Maged Mahmoud, et al., “Assessment of the Status of Solar PV in Yemen,” Worldbank, May 2017, <https://documents1.worldbank.org/curated/en/284461511876486207/text/121707-WP-PUBLIC-P158449-WB-RCREEE-Solar-PV-in-Yemen-Report-002.txt>.

33 See International Energy Agency: <https://www.iea.org/countries/yemen/renewables>

Since 2018, there has been a growing interest in medium-to-large-scale solar energy plants, primarily driven by the government’s efforts to address the energy crisis.³⁴ This has led to the development of several significant solar initiatives aimed at expanding renewable energy capacity. The Aden Solar Plant, with a capacity of 120 MW, came online in 2024, representing the largest renewable energy project. Additionally, solar projects are underway in various regions, including a 25 MW project in Al-Makha in Taiz, a 56 MW installation in Shabwa, and combined projects in Al-Khawkhah and Hays districts in southern Hudaydah with a total capacity of 50 MW.³⁵

1.2.2 Current Energy Policy Frameworks in Yemen

The energy regulatory framework in Yemen consists of various laws, strategies, and plans designed to address the country’s ongoing energy challenges. The Electricity Law (2009)³⁶ serves as the foundational legal framework, outlining the roles and responsibilities of key entities involved in generating, transmitting, and distributing electricity. It also promotes the sector’s liberalization to encourage private sector participation, including a greater role for independent power producers, and Public Private Partnership, as well as greater involvement in different stages of the upstream fuel supply. The National Strategy for Renewable Energy and Energy Efficiency (RENEE, 2009) established targets for integrating renewable energy into the national grid and enhancing energy efficiency, recognizing the country’s significant potential for solar and wind power. The strategy sets targets for various scenarios, with the base scenario aiming to achieve 15 to 20 percent of grid electricity generated from renewable energy sources by 2025.³⁷

The RENE strategy incorporates poverty alleviation

34 Abeer Al-Eryani, “The Political Economy of Energy Security in Wartime Yemen,” Brill, October 17, 2024, <https://doi.org/10.1163/18763375-20241480>.

35 These figures were reported during focus group discussions and key informant interviews held between November 2024 and February 2025.

36 Law No.1 of 2009 on Electricity. See: https://climate-laws.org/document/law-no-1-of-2009-on-electricity_5fa6

37 For more information on the organizational structure and other sector-related technical details, refer to Akram M. Almohamadi, “Priorities for the Recovery and Reform of the Electricity Sector in Yemen,” Sana’a Center for Strategic Studies, May 25, 2021, <https://sanaacenter.org/publications/main-publications/14292> and other relevant Sana’a Center publications

and the protection of vulnerable populations from potential increases in energy costs as key objectives. It emphasizes decentralization and rural electrification as essential components for achieving these goals, aiming to enhance energy access, promote economic development, and ensure energy equity across underserved communities. Moreover, it identifies several renewable energy sources, with solar, wind, geothermal, and landfill gas being the most viable. The recommended energy mix has since been updated to include natural gas.

Yemen’s government is working with international development partners to develop the Renewable Energy and Recovery Investment Plan. This builds on the draft National Renewable Energy Strategy (2009) and Article 17 of the 2009 Electricity Law, which encourages investment in renewable energy. This plan aims to attract investment in renewable energy projects as part of post-conflict recovery efforts. It outlines the necessary investment requirements in generation, transmission, and distribution networks, which amount to more than US\$4 billion to US\$7 billion by 2030,³⁸ along with proposed pilot projects, a procurement process, and a capacity-building plan.³⁹ It also includes a Gender Action Plan that outlines the methods for the inclusion and participation of women in decision-making and the renewable energy sector workforce.

Energy efficiency plays a vital role in Yemen’s carbon mitigation strategies by targeting reductions in electricity transmission losses and promoting the adoption of energy-efficient technologies. However, there is no comprehensive policy framework that outlines how these targets will be met. The UNDP-led Technology Needs Assessment report⁴⁰ identifies the top four potential mitigation options for the energy sector as:

1. Light-Emitting Diode (LED) Lighting,
2. Off-grid and On-grid Solar Photovoltaic (PV) Systems,
3. Wind Turbines, and

38 Based on key informant interviews and internal documents shared by government stakeholders and technical experts.

39 Based on a draft version of the document shared with researcher prior to its official publication.

40 “Yemen – Technology Needs Assessment,” United Nations Environment Programme Copenhagen Climate Centre, accessed February 8, 2025, <https://tech-action.unepccc.org/country/yemen/>

4. Solar Water Heating Systems.

These options and new developments in the policy arena offer significant potential for decarbonization and green developments. Still, their success will depend on developing robust regulatory policies, institutional coordination, and investment in renewable energy infrastructure.

2. Toward a Just and Conflict-Sensitive Energy Transition in Yemen

Yemen is actively engaged in global efforts to reduce carbon emissions through its commitments and participation in international initiatives. To meet these commitments, the country must transition away from its reliance on hydrocarbon-based energy systems. Despite its minimal contribution to global emissions, its acute vulnerability to climate change, particularly in coastal areas that continue to suffer from prolonged and severe heatwaves, underscores the urgency of accelerating these efforts. Moreover, if no action is taken against climate change, Yemen is projected to face cumulative losses of US\$93 billion in GDP by 2060.⁴¹

Decentralized and clean power systems, such as solar-powered systems and hybrid power generation, decrease vulnerability by reducing dependence on fossil fuel supply chains and making public services more resilient to the impacts of climate change, including extreme heat, floods, and droughts. Increased electrification through decentralized systems enables communities to safeguard essential service delivery (such as schools, health, and water) and reduce emissions, thereby aiding climate adaptation by making the energy system more resilient and reliable in the face of shocks. A cleaner decentralized system not only makes the country less vulnerable to climate shocks and pollution, but is demonstrated to enable economic recovery, better health for the Yemeni

population, and climate-resilient development.⁴²

However, the transition poses significant challenges due to the country's heavy dependence on the oil sector, which accounted for 27 percent of GDP, 50 percent of national budget revenue, and 70 percent of exports in 2021.⁴³ Despite a significant decline in oil exports since 2022, the sector is expected to remain a primary source of government revenue once it recovers.

Since 2015, Yemen has suffered severe economic losses, with its GDP shrinking by approximately 43 percent in real terms and by more than 70 percent on a per capita basis between 2015 and 2024. The crisis has pushed more than 74 percent of the population into extreme poverty while worsening undernutrition and health conditions.⁴⁴ Yemen faces compounded resource limitations alongside technical and bureaucratic challenges, such as weak institutional capacity and a lack of a coherent climate policy, in accessing climate finance, which is crucial for implementing its energy transition strategies. Despite the urgent need for funding, Yemen's access to global climate financing has been minimal, especially in comparison to other countries and even within its own group of LDCs.⁴⁵

These factors underscore the importance of urgent and comprehensive collaboration with global partners. Enhancing Yemen's access to global green funds is crucial not only for addressing immediate climate-related vulnerabilities and supporting long-term energy transition strategies but also for ensuring that these efforts complement the peace building process.

As of 2021, only 12 percent of Yemen's population had access to public electricity, compared to

41 "Yemen Country Programme," Green Climate Fund, October 22, 2024, <https://www.greenclimate.fund/document/yemen-country-programme>

42 "Yemen Country Climate and Development Report," World Bank, November 20, 2024, <https://documents1.worldbank.org/curated/en/099111824082513798/pdf/P5006381020b8409e187c718d-3ed64b0d9b.pdf;Lighting> the path to recovery with renewable energy in Yemen", UNDP, 2024, <https://www.undp.org/yemen/news/lighting-path-recovery-renewable-energy-yemen>.

43 "Yemen Economic Monitor Fall 2024: Confronting Escalating Challenges," World Bank, Fall 2024, <https://openknowledge.worldbank.org/entities/publication/ee32e2b8-09e6-4d7d-8629-89102a436f42>

44 "Yemen Economic Monitor, Spring 2025: Persistent Fragility amid Rising Risks," World Bank, Spring 2025, <https://openknowledge.worldbank.org/entities/publication/cc22675d-e06c-466e-be62-a2c290c2a86e>

45 "GCF Open Data Library," Green Climate Fund, accessed February 7, 2025, https://data.greenclimate.fund/public?_gl=1*14w3y9r*_ga*MTQ040TAyNDQ3Ni4xNzM4ODY2ODU3*_ga_1G93H3NS-BL*MTczODkzNTY2NS4yLjEuMTczODkzNTgxNi4wLjAuMA.

Table 1: Change in electricity tariffs over time and across regions. Source: Communications with the Ministry of Electricity and Energy (internationally recognized government) and the Ministry of Electricity and Public Electricity Corporation (Sana’a-based authorities).

HCA	Government
2015–19: YR 160 to 240/kWh (US\$ 0.96)	2015–17: YR 16 to 30/kWh (US\$ 0.12)
2020–24: YR 300–480/kWh (US\$ 1.00)	2018–24: YR 70/kWh (US\$ 0.28)

approximately 40 percent before the war.⁴⁶ This significant decline results mainly from the ongoing conflict, which has rendered most of the power grid inoperable since 2015. The shortfall in generation capacity is further exacerbated by Yemen’s energy mix, which relies heavily on diesel and heavy fuel oil – both of which have faced significant supply disruptions during the conflict.⁴⁷

The collapse⁴⁸ of the national grid has intensified horizontal inequalities, extending beyond the traditional urban-rural divide to include stark disparities between areas under different jurisdictions. While some government-controlled regions retain limited access to public electricity, areas under the Houthi group rely almost entirely on costly, privately supplied power. This has sharply driven up energy costs, deepening economic hardship nationwide, with residents in Houthi-controlled areas paying significantly more for electricity (Table 1). These dynamics are not only exacerbating political and economic risks but also fueling new grievances and widening existing inequalities.⁴⁹

In many rural and peri-urban areas, collecting firewood has become the primary source of energy for cooking and heating. This significantly affects vegetation cover and negatively impacts the health and well-being of those collecting firewood, the majority of whom are primarily women.⁵⁰ It also imposes a disproportionate burden on women and low-income communities, often requiring extensive time for collection, and increases their exposure to indoor pollution. Before the war, firewood collection was mainly confined to rural areas; however, in recent years, urban populations have also increasingly relied on biomass and inefficient fuels. This shift has likely led to higher rates of indoor air pollution and, consequently, an increase in respiratory diseases.

Since the start of the war, the number of internally displaced persons (IDPs) in Yemen has risen to 4.5 million.⁵¹ Many of them live in dire conditions with limited access to basic services, relying heavily on humanitarian aid agencies as their primary lifeline. The decreasing cost of solar PV technologies has enabled many of these communities to receive solar energy systems, improving their access to essential services.⁵² While these interventions

46 “Illuminating Lives: Bringing Light and Hope to Djibouti and Yemen,” Results Brief, World Bank, March, 2025: <https://www.worldbank.org/en/results/2025/03/26/illuminating-lives-bringing-light-and-hope-to-djibouti-and-yemen#:~:text=The%20World%20Bank%20estimates%20that,of%20grid%20electricity%20a%20day>.

47 See Yemen Economic Tracking Initiative: <https://yemen.yeti.acaps.org/monitoring-timeline/>

48 Even in the limited areas where the grid still functions, the grid fails to operate reliably, with many Yemeni cities experience power outages that last for months. There have been, however, partial improvements, such as in Aden and in Al-Makha, where solar power plants have been established.

49 Abeer Al-Eryani, “The Political Economy of Energy Security in Wartime

Yemen,” Brill, October 17, 2024, <https://doi.org/10.1163/18763375-20241480>.

50 “Yemen Cooking Gas Crisis Exacerbates Firewood,” HolmAkhdar, September 6, 2021, <https://holmakhdar.org/reports/4579/>.

51 “Internally Displaced Persons IDP-Yemen,” Internal Displacement Monitoring Centre (IDMC), <https://www.internal-displacement.org/countries/yemen>

52 “Solar empowerment in Yemen,” United Nations, Department of Economic and Social Affairs, <https://www.un.org/nl/desa/solar-empowerment-yemen>; “Solar Interventions in Yemen,” UNDP, August 2, 2021, <https://www.undp.org/yemen/publications/solar-interventions-yemen>

are crucial, it is equally important to assess their broader social impacts on host communities to ensure that they are conflict-sensitive and promote justice.⁵³ Moreover, despite the promise of solar PV technology, it remains insufficient to meet the needs of the majority of impoverished populations in Yemen's hotter coastal regions, such as Aden and Hudaydah, where extreme summer temperatures present additional significant challenges.

Energy sector subsidies constitute the most significant burden on the national budget,⁵⁴ characterized by an opaque structure that fosters inefficiency, waste, and corruption. Despite the substantial fiscal outlay, the actual benefits received by citizens are minimal.⁵⁵ The adverse effects of the current subsidy system extend beyond economic inefficiency, contributing to severe political and economic ramifications. Notably, the erosion of government legitimacy, compounded by public dissatisfaction over inequitable energy access, has heightened the risk of conflict.⁵⁶

2.1 Policy Gaps

Fragmentation and Exclusion in Energy Policy:

Yemen's current energy transition frameworks are disjointed, underdeveloped, and lack cohesion. Two major issues stand out: 1) the lack of integration and coordination among existing policies; and 2) the need to meaningfully address inclusion and justice in depth, rather than just paying lip service to these concepts. Crucial to this is the revision and updating of relevant frameworks, such as poverty reduction strategies,⁵⁷ to align with climate

adaptation and clean energy goals, thereby ensuring a comprehensive framework that can guide the transition to low-carbon, climate-resilient energy systems in a fair and sustainable manner. While national adaptation plans acknowledge the challenges faced by communities and the struggles of impoverished and marginalized groups, they often do not explicitly include critical segments of the population, such as women, individuals with disabilities, and other marginalized demographics. Moreover, decentralized energy systems should be integrated into the adaptation plans and selected projects. This is particularly important in Yemen, where existing challenges in electricity access hinder communities' ability to respond and prepare for extreme climate events.

Underserved Communities: Decentralized and off-grid electricity generation strategies remain underdeveloped. Currently, they are primarily addressed within the Renewable Energy and Energy Efficiency (RENEE) framework and incorporated into the broader objectives of rural electrification, which falls under the mandate of the Rural Electrification Authority. There is a critical need for a comprehensive policy that aligns with the expansion of economic opportunities for local communities. This policy should include the development of policy instruments and a governance framework that fosters job creation and supports diverse ownership structures, such as cooperatives and community-owned energy initiatives.

Underdeveloped Energy Efficiency Measures:

Energy efficiency is another critical yet underdeveloped area of intervention and policy-making. It can be addressed both at the grid level and within the broader energy system. These policies need to be developed and should encompass measures at different levels. Current policies focus on centralized energy generation and large industrial consumers. Strategies to include and address issues affecting user segments, such as households and small commercial end-users, should be incorporated to understand the implications and solutions pertaining to these groups.

53 Jennifer Alix-Garcia and David Saah, "The Effect of Refugee Inflows on Host Communities: Evidence from Tanzania," SSRN Electronic Journal, 2008, <https://doi.org/10.2139/ssrn.836147>

54 "Yemen Economic Monitor: Confronting Escalating Challenges," World Bank, Fall 2024, <https://documents1.worldbank.org/curated/en/099943010292431765/pdf/IDU1f65eefe71d-79414f1618a511921980f32f1b.pdf>

55 Bassam Fattouh and Laura El-Katiri, "Energy Subsidies in the Middle East and North Africa," Energy Strategy Reviews, Strategy Options and Models for the Middle East and North Africa (MENA) Energy Transition, Volume 2, Issue no. 1 (June 1, 2013): pp. 108–15, <https://doi.org/10.1016/j.esr.2012.11.004>

56 Abeer Al-Eryani, "The Political Economy of Energy Security in Wartime Yemen," Brill, October 17, 2024, <https://doi.org/10.1163/18763375-20241480>.

57 Most of the development and social protection strategies are currently suspended or fragmented. The National Poverty Reduction Strategy ended in 2010, and the Transitional Plan for Development and Sta-

bilization was suspended by 2014. Since then, social protection and humanitarian assistance have largely been channeled through international aid, with very limited coordination with the government and virtually none across the different factions in the country.

Reliance on Natural Gas: Natural gas, once considered an unlikely long-term energy source in the 2009 strategy, has now become central to most planned new capacity. Relying on natural gas as a transition fuel raises concerns about the availability of resources and the sustainability of Yemen’s energy transition. This approach risks creating carbon lock-in in infrastructure and institutions due to the substantial investments needed for pipeline infrastructure, as well as the potential for rent-seeking and corruption associated with large-scale projects.

Weak and Disjointed Energy Data Systems: Finally, Yemen’s energy policy is profoundly undermined by incomplete, fragmented, and poorly coordinated data systems. Critical information on supply capacity, energy access, demand patterns, and renewable energy integration is often sporadic, outdated, or entirely missing – an outcome of institutional breakdown, pervasive conflict, and resource constraints. The lack of standardized data collection methods and a central repository lead to significant and sometimes contradictory discrepancies in reported statistics. Different stakeholders – including governmental agencies and international institutions – often rely on divergent or mutually incomprehensible datasets, further complicating energy planning, emergency response, and accountability. Yemen can here benefit from the experience of other countries, including Nigeria’s Integrated Energy Planning Tool, which adopts a digital platform to improve data coordination.⁵⁸

58 Nigeria’s digital tool integrates geospatial, demographic, infrastructure, and market data into a user-friendly, interactive digital platform, enabling stakeholders to accurately map real-world energy needs, evaluate least-cost electrification strategies, and plan technology deployment down to the community level. By supporting collaboration across government agencies, local authorities, and the private sector, the tool has improved both strategic planning and on-the-ground implementation. For Yemen, developing a similar digital platform could transform sectoral coordination: empowering evidence-based policy-making, supporting equitable off-grid electrification, and bridging humanitarian and development responses. See Nigeria’s Integrated Energy Planning Tool, <https://nigeria-iep.sdg7energyplanning.org/>

3. Current Opportunities and Future Pathways

3.1 Grassroots Developments

One consequence of the public grid’s collapse in 2015 was the widespread adoption of solar PV technologies.⁵⁹ It is estimated that between 2015 and 2017, over US\$1 billion was spent on imported solar home systems. Over 70 percent of Yemenis have turned to small-scale solar systems.⁶⁰ Although there has been a shift toward hybrid models,⁶¹ the broad adoption of renewable energy technologies has led to greater societal awareness. This change has also generated key activities essential for creating a local innovation and adaptation ecosystem.⁶² This encompasses job creation, knowledge generation, collaboration networks, and engagement with civil society, among other initiatives.

Job creation: A 2023 study by the World Bank and ESMAP estimated that Yemen’s solar PV sector could become a significant source of employment by 2030. Under the low-deployment scenario, the sector is projected to generate approximately 6,200 direct jobs, 4,700 indirect jobs, and roughly 11,000 induced jobs, in addition to an additional 10,000 jobs associated with the productive use of solar energy.⁶³

59 Assessment of the status of Solar PV in Yemen, World Bank-RECREEE 2017, <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/284461511876486207>

60 Mansoor Albashiry, “The Private Sector and Renewable Energy in Yemen: Status Quo and Partnership Requirements,” Federation of Yemeni Chambers of Commerce and Industry, June 2024, <https://fycci-ye.org/upload/1720626523.pdf>

61 Many households in areas without access to the public grid report relying on a combination of solar PV and commercial (diesel-based) electricity. In grid-connected areas, initial observations and pilot interviews suggest that some households use batteries to store electricity from the grid in anticipation of blackouts, alongside an increasing reliance on solar PV systems.

62 Kassahun Y. Kebede and Toshio Mitsufuji, “Technological Innovation System Building for Diffusion of Renewable Energy Technology: A Case of Solar PV Systems in Ethiopia,” *Technological Forecasting and Social Change* 114 (January 1, 2017): 242–53, <https://doi.org/10.1016/j.techfore.2016.08.018>

63 “The Employment Benefits of an Energy Transition in Yemen,” ESMAP,

Direct employment is expected to be concentrated in five core segments: sales and distribution; installation; maintenance; training and education; and manufacturing.⁶⁴ Depending on the scale of deployment and the scenario modeled, the sector’s total employment potential ranges between 11,000 and 59,000 jobs.⁶⁵ These findings underscore the pivotal role that decentralized solar PV can play in alleviating energy poverty, supporting livelihoods, and promoting inclusive economic recovery and growth within Yemen’s fragile and conflict-affected context.

Education and Training: Since 2015, there has been a significant increase in solar energy-related educational and vocational training programs. The University of Sana’a and Taiz University, for example, have introduced sub-tracks focusing on Solar PV (or renewable energy) within their Electrical Engineering programs. Similarly, several vocational training institutes began offering courses in Solar Systems design, installation, and maintenance in 2016. Private universities followed suit, with some providing dedicated programs in renewable energy. Other training opportunities continue to be offered by NGOs to women and various other beneficiaries.⁶⁶

Networks: Various formal and informal networks have been established around renewable energy projects.⁶⁷ Some of these networks focus on addressing issues in the power sector and involve technical and administrative staff from relevant ministries across the conflict divide. Others are project-focused and bring together civil society and

private sector stakeholders to engage in project implementation. Donor initiatives primarily drive these collaborations and knowledge-sharing networks. However, while project focus often struggles to endure beyond the project’s duration, cross-ministerial networks tend to have greater longevity as they build on informal networks and collegiality.

Civil society and NGOs: Local NGOs are essential partners with the donor community in implementing various humanitarian and development initiatives that include solar PV components. Furthermore, there has been an increase in new NGOs whose primary focus is renewable energy, highlighting the rising importance and awareness in the sector.⁶⁸

Adaptive practices: Households have developed informal skills and adaptation practices in response to the energy crisis, largely influenced by the widespread adoption of solar PV. Women, in particular, employ various adaptive strategies, such as alternating between solar power and other energy sources based on the energy demands of specific domestic tasks.⁶⁹ Moreover, while data on the scale of diffusion of energy-efficient appliances and smart meters is limited, reports indicate a significant shift toward the adoption of energy-efficient appliances alongside the spread of solar PV technologies, as well as an increasing use of the grassroots adoption of smart meters to optimize energy consumption.⁷⁰

April 1, 2023, https://www.esmap.org/Jobs_in_Energy_Transition_Yemen; “Solar Energy Systems Value Chain,” UNDP, August 5, 2020, <https://www.undp.org/yemen/publications/solar-energy-systems-value-chain>

64 Triangulated data from World Bank–ESMAP (2023), UNDP–ESMAP (2020), and interviews with sectoral experts.

65 “The Employment Benefits of an Energy Transition in Yemen,” ESMAP, April 1, 2023, https://www.esmap.org/Jobs_in_Energy_Transition_Yemen; “Solar Energy Systems Value Chain,” UNDP, August 5, 2020, <https://www.undp.org/yemen/publications/solar-energy-systems-value-chain>

66 The findings are based on household and key informant interviews, and a document analysis carried out as part of the lead author’s forthcoming research on the development of the solar PV niche in Yemen.

67 Ayoub, MacCulloch, Otayek, Kashman, Al-Eryani “What Drives Solar Energy Development? Evidence from Lebanon, Jordan, and Yemen” AUB Issam Fares Institute for Public Policy and International Affairs, Natural Resource Governance Institute, 2022 <https://www.aub.edu.lb/ifi/Documents/solar-energy-development-lebanon-jordan-yemen.pdf?fbclid=IwAR1nYITb>

68 While there is no comprehensive data on the number of new NGOs working on solar PV, a few such as Musandah (<https://musandah.org/>), have emerged as particularly visible and influential. According to discussions with key informants and interviews with local NGOs, many respondents also highlighted the role of small, local NGOs operating at the governorate or district level, often in collaboration with more established organizations.

69 Derived from pilot interviews with lead researcher conducted in the context of a separate research project.

70 The findings are based on household and key informant interviews, and document analysis carried out as part of the lead author’s forthcoming research on the development of the solar PV niche in Yemen.

3.2 Rural Electrification as a Peace Dividend

Investing in solar energy projects in rural Yemen presents a viable opportunity to address the nation's profound energy crisis while promoting sustainable development. The abundant solar resources, coupled with the pressing need for reliable electricity in both rural and urban areas, make solar photovoltaic (PV) technology an essential component of Yemen's energy strategy. Rural areas offer the necessary land required for large-scale solar arrays, a resource severely constrained in densely populated urban centers.⁷¹ By bridging this rural energy gap, solar investments also help urban areas where energy shortages are catastrophic, and the expansion of large-scale solar farms is hampered by limited space and high land costs.⁷² Investment in solar energy projects in rural Yemen is crucial to address energy shortages in both rural and urban settings effectively.⁷³

Rural populations suffer from near-total exclusion from the fragmented national grid, severely limiting access to basic services, economic activity, and humanitarian aid. Therefore, investment in rural solar energy is not only a lifeline for millions but an essential foundation for enhanced resilience, Yemen's recovery, social stability, and long-term economic growth, as it provides vital power for crucial services like domestic water pumping, healthcare clinics,⁷⁴ supporting income-generating activities, and enterprise growth within rural communities.

Lessons from China in this context are helpful. China's photovoltaic poverty alleviation initiative

(PVPA) is a model that directly targets rural poverty and supports achieving a just energy transition through institutionalized mechanisms for procedural justice,⁷⁵ resulting in positive material impacts on rural households.⁷⁶ PVPA is notable because it aims to fight rural poverty and promote clean energy. It emphasizes energy-saving measures and low-carbon initiatives are a tailored approach that developing countries can adapt by developing similar strategies for energy efficiency, utilizing renewable resources, and implementing policies that promote sustainable development.⁷⁷ The initiative is widely recognized as an innovative model for "green" poverty alleviation, where poor households receive direct income from selling generated electricity to the grid. The reported annual income increase was about US\$420 per household, benefiting over 4 million families,⁷⁸ despite limitations in effectiveness by district, village administration, and PV maintenance quality.⁷⁹

71 Experts' FGD conducted in June 2025.

72 Ansari, Dawud, Claudia Kemfert, and Hashem al-Kuhlani, "Yemen's Solar Revolution: Developments, Challenges, Opportunities," White Paper No. 2019/02. Berlin, Germany: Energy Access and Development Program (EADP); DIW Berlin; Hertie School of Governance, February 2019, https://eadp.eu/uploads/WP201902_Yemen_Solar_EN.pdf

73 Al-Ashwal, A. M., "Sustainable energy services strategy for rural areas in Yemen," In A. A. M. Sayigh (Ed.), *Renewable Energy: World Renewable Energy Congress VI*, July 2000, pp. 1748–1754, <https://www.sciencedirect.com/science/article/abs/pii/B9780080438658503640?via%3DI-hub>

74 Hadwan, M., & Alkholidi, A. (2016), Solar power energy solutions for Yemeni rural villages and desert communities, *Renewable & Sustainable Energy Reviews*, Volume 57, pp. 838–849, <https://doi.org/10.1016/j.rser.2015.12.125>

75 Procedural justice is one of the core elements of justice frameworks, alongside distributive and recognition justice. It refers to the fairness and transparency of decision-making processes, ensuring that all stakeholders have a voice, procedures are applied consistently, and decisions are made impartially and respectfully.

76 Lo, K. (2021), "Can authoritarian regimes achieve just energy transition? Evidence from China's solar photovoltaic poverty alleviation initiative." *Energy Research and Social Science*, Volume 82, 102315, <https://doi.org/10.1016/j.ERSS.2021.102315>

77 Zhang, Huiming, Kai Wu, Yueming Qiu, Gabriel Chan, Shouyang Wang, Dequn Zhou and Xianqiang Ren, "Solar Photovoltaic Interventions Have Reduced Rural Poverty in China," *Nature Communications*, April 23, 2020, <https://www.nature.com/articles/s41467-020-15826-4>

78 Han Xiao, Feng Song, Xinye Zheng, Jiaying Chen, "Community-based energy revolution: An evaluation of China's photovoltaic poverty alleviation program's economic and social benefits," *Elsevier Journal*, 2023, *<http://ae.ruc.edu.cn/docs/2023-05/06cfed579652429f9a5f9952b-cb3579f.pdf>

79 Xu, Shengqing, Qiuyan Zhang, and Luyu Yang. "Policy Evaluation and Optimization for Photovoltaic Poverty Alleviation Projects in Anhui Province of China," *Scientific Reports*, September 27, 2024, <https://www.nature.com/articles/s41598-024-73545-y>

4. Conclusion

Yemen's energy-political crisis and its broad social and economic impacts have made the energy sector a top policy priority. While this creates opportunities, there's a key risk: focusing on short-term fixes over a just and sustainable energy transition. To address this issue, it is crucial to strike a balance – meeting immediate energy needs while laying the groundwork for an equitable and long-term transformation. This policy brief advocates for an incremental energy planning approach that identifies and prioritizes viable interventions to address immediate challenges, while maintaining a strong focus on sustainability, inclusivity, and resilience.

Despite facing significant constraints, positive developments have emerged that can be leveraged to support a just and conflict-sensitive transition. As explored above, there has been a widespread adoption of solar PV solutions among households, small businesses, and the humanitarian sector. Additionally, new local actors and NGOs dedicated to sustainable energy are emerging. Rather than being dismissed as temporary coping mechanisms, these decentralized initiatives should be recognized as sites of institutional experimentation and socio-technical innovation. Harnessing their collective impact could serve as a vital pathway to inclusive energy access.

While expanding and maintaining the national grid remains a core priority, interventions must be strategic – targeting improvements to existing infrastructure while building on decentralized systems with future grid integration in mind. A systemic planning approach enables more coherent and effective decision-making, aligning decentralized energy deployment with broader developmental objectives.

Small-scale solar PV systems can address basic needs such as lighting and communication; however, more substantial systems are necessary to support productive uses and community-scale services. Planning must therefore consider the scalability of systems and their technical compatibility with the grid, facilitating future integration through policies such as net metering and feed-in tariffs.

To support this transition, policy should focus on establishing robust quality standards for imported equipment and restructuring subsidy

schemes to ensure a seamless transition. Instead of concentrating subsidies at the level of IPPs, incentives should be redirected to support end-user adoption, particularly in underserved areas.

Ultimately, Yemen needs to adopt a context-specific framework to guide its energy transition – one that is sensitive to local conditions, institutional capacities, and social equity. The following section presents specific recommendations, structured to balance immediate energy imperatives with long-term objectives through targeted, strategic interventions.

5. Recommendations

To ensure that Yemen's energy transition is just, conflict-sensitive, and aligned with peace-building efforts, a two-track intervention approach is recommended. The first track should focus on strategic priorities that enable coordinated efforts across different stakeholders, targeting key capabilities and frameworks to address overlapping challenges. The second track should concentrate on updating and developing relevant policies and strategies, in close collaboration with stakeholders, to support the implementation of equitable and conflict-sensitive energy transition objectives. To reflect these priorities, the recommendations are organized into two main categories as follows:

Strategic Areas of Action

Develop a Comprehensive Data Infrastructure to Support Informed Energy Transition Planning.

The current landscape for energy data in Yemen is fragmented and lacks coordination. While climate and environment-related data are relatively well-structured and benefit from clearer institutional frameworks, energy data remain dispersed across sectors, limiting their accessibility and utility for evidence-based policy-making. Developing comprehensive mechanisms for data collection and management across the energy transition landscape is essential to support a coherent strategy and ensure that related cross-sectoral policies are relevant, aligned, and mutually reinforcing.

This includes establishing centralized databases, implementing standardized collection protocols,

and creating sharing mechanisms between different regions, sectors, and authorities. To maximize effectiveness and ensure sustainability, international technical support must be strategically designed with cost-efficiency as a core principle. While international expertise is valuable, its high costs can strain limited resources and potentially divert funding from essential activities. Therefore, technical assistance programs should prioritize sustainable knowledge transfer and long-term capacity building for national authorities.

A robust data infrastructure will strengthen Yemen's capacity across multiple strategic areas. Primarily, it will enhance the country's ability to track progress, assess project impacts, update policies, and demonstrate alignment with global climate commitments. It will strengthen institutional capabilities to develop and update evidence-based policies that reflect ground realities. Furthermore, comprehensive and reliable data management will facilitate Yemen's access to international climate mitigation funding, adaptation finance, and infrastructure investment platforms by providing the transparency and accountability these mechanisms require. Such infrastructure serves as the foundation for developing and maintaining a robust Monitoring, Verification, and Reporting system, essential for participating in global climate initiatives and accessing climate finance. It will also underpin digital planning tools that integrate data across relevant sectors, enabling more holistic modeling of different policy options. The system will allow real-time monitoring of energy transition progress, support adaptive policy-making, and provide credible evidence of Yemen's commitment to broader sustainable development goals.

Develop a Just and Conflict-Sensitive Energy Transition Framework

Yemen's energy transition requires a carefully structured framework that reflects the country's unique context, priorities, and challenges. This framework must serve as the foundation for a just and conflict-sensitive energy transition, fulfilling two critical functions. First, it should guide the development of a comprehensive national energy transition plan by establishing clear guidelines, defining key concepts, and outlining specific procedures and targets. Second, it should provide a systematic framework for project selection and prioritization, including the use of well-defined evaluation metrics to ensure coherence

and alignment across strategic objectives. Given Yemen's resource constraints, the framework must include robust prioritization criteria to identify interventions with the most significant potential to advance both energy transition goals and broader justice and peace-building objectives.

The ongoing development of Yemen's National Adaptation Plan (NAP) provides a strategic opportunity to integrate energy transition planning within broader climate adaptation strategies. While global energy transitions typically emphasize emissions reduction, Yemen's context demands a more comprehensive approach that recognizes the fundamental role of energy in climate resilience. Reliable and affordable energy access is crucial for strengthening adaptive capacity, particularly in critical sectors such as agriculture, water management, and public health. Therefore, the NAP should incorporate a justice and peace-building-oriented framework that ensures energy projects deliver multiple benefits: decarbonization, conflict mitigation, economic recovery, and equitable access.

Rethinking Rural Electrification for Equity and Innovation

Revitalizing rural electrification plans should be a strategic priority for several interrelated reasons. First, a substantial portion of Yemen's rural population remains without access to electricity, exacerbating socio-economic marginalization and inequality. Second, expanding rural electrification can unlock local economic potential by enabling the productive use of energy in agriculture, healthcare, services, and small-scale industries. Third, rural areas offer valuable sites for experimentation with decentralized and off-grid energy solutions, providing opportunities to pilot innovative low-carbon technologies as well as alternative governance and business models in contexts less reliant on national grid infrastructure.

Moreover, given the persistent challenges facing large-scale infrastructure projects and centralized policy implementation in Yemen, decentralized rural interventions are more feasible and may yield more immediate and tangible outcomes. Their benefits can extend beyond energy access to include capacity building at the community level and the enhancement of local governance structures – both of which are essential for rebuilding public trust and strengthening state legitimacy in fragile contexts.

Stakeholder-Specific Recommendations

Government

- Strengthen policy and institutional frameworks through building a robust data infrastructure and aligning national energy transition, climate adaptation, and economic and social development policies.
- Build strategic regional and international partnerships for technical and financial support beyond conventional partners.
- Integrate energy transition planning with peace-building objectives.
- Reform energy subsidies to improve efficiency, to phase out fossil fuel subsidies, create a transitional period based on user categories and vulnerability, and shift necessary subsidies toward renewable energy sources
- Create incentives for off-grid, decentralized, community-led, and community-owned energy projects.
- Develop strategies to mobilize and channel remittances and diaspora investment into renewable energy projects.
- Integrate Gender Equality, Disability, and Social Inclusion in Energy policy design and implementation, paying attention to intersectionality.
- Accelerate and advance existing plans to unbundle the electricity sector by separating generation, transmission, distribution, and retail into distinct, independently managed and regulated entities, overcoming current implementation delays.

International and Regional Partners

- Consider flexible and conflict-sensitive funding mechanisms.
- Encourage local collaboration across conflict divides. Anecdotal evidence indicates that international aid agencies can play a role in fostering and legitimizing project-based partnerships in these areas. By highlighting mutual benefits and showcasing positive outcomes, these collaborations can be

strengthened and become more effective. De-risk investment through support access to and promotion of blended finance mechanisms.

- Ensure that individual projects align with a system-wide approach that supports the development of a diffusion-based local solar PV innovation and adaptation system, with a focus on strengthening the institutional and structural components within the local solar PV ecosystem. Maintain consistent long-term support of stakeholder networks beyond individual projects.
- Promote Energy as a tool for peace building. In addition to fostering project-based collaboration across regions, this can be achieved by enhancing participatory energy decision-making at all levels and ensuring that local energy interventions do not exacerbate existing social and political tensions and grievances.

Civil society

- Advocate for inclusive and just energy policies across all levels of interaction with the donor community, as well as with stakeholders in the projects and communities engaged with. Recognize and highlight the intersection of energy, climate, and justice issues, emphasizing how these challenges are embedded within broader social, political, and economic contexts, and work to raise public awareness on these critical issues.
- Actively seek to engage in policy dialogues and decision-making processes. This involves not only attending consultations, meetings, and forums, but also following up on commitments and raising critical issues.
- Leverage existing relations with stakeholders to facilitate meaningful community participation in energy decision-making. Civil society organizations can act as bridges between local communities, project implementers, and policymakers, ensuring that community perspectives inform project design, governance structures, and resource allocation.
- Develop financial and technical literacy within the organization to build the capacity for meaningful engagement in renewable energy initiatives. At the same time, foster knowledge-

sharing networks among diverse actors to exchange experiences and best practices, and to deepen understanding of the conditions that allow specific commercial and community-based energy projects to succeed in some contexts but not others.

Private sector

- Foster partnerships with local authorities and NGOs to develop sustainable business models.
- Align business models with conflict-sensitive approaches that promote inclusive and equitable energy access, particularly for vulnerable and underserved communities. Conflict-sensitive approaches ensure that projects are resilient and increase their long-term sustainability.
- Leverage available international support systems by partnering with global organizations to invest in local workforce development.
- Explore a range of financial mechanisms relevant to the energy transition within the global climate resilience landscape, and leverage blended finance and donor-backed guarantees to mitigate financial risks.
- Engage in the development and adoption of technical standards to strengthen quality assurance, safety, and interoperability within the renewable energy sector. While investing in quality assurance and adhering to standards may increase initial costs, it ultimately reduces risks for both consumers and investors, enhances system reliability, and strengthens trust in the sector.
- Establish a robust maintenance network and after-sales services.

About the Arab Reform Initiative

The Arab Reform Initiative is an independent Arab think tank working with expert partners in the Middle East and North Africa and beyond to articulate a home-grown agenda for democratic change and social justice. It conducts research and policy analysis and provides a platform for inspirational voices based on the principles of diversity, impartiality, and gender equality.



contact@arab-reform.net
Paris - Beirut - Tunis