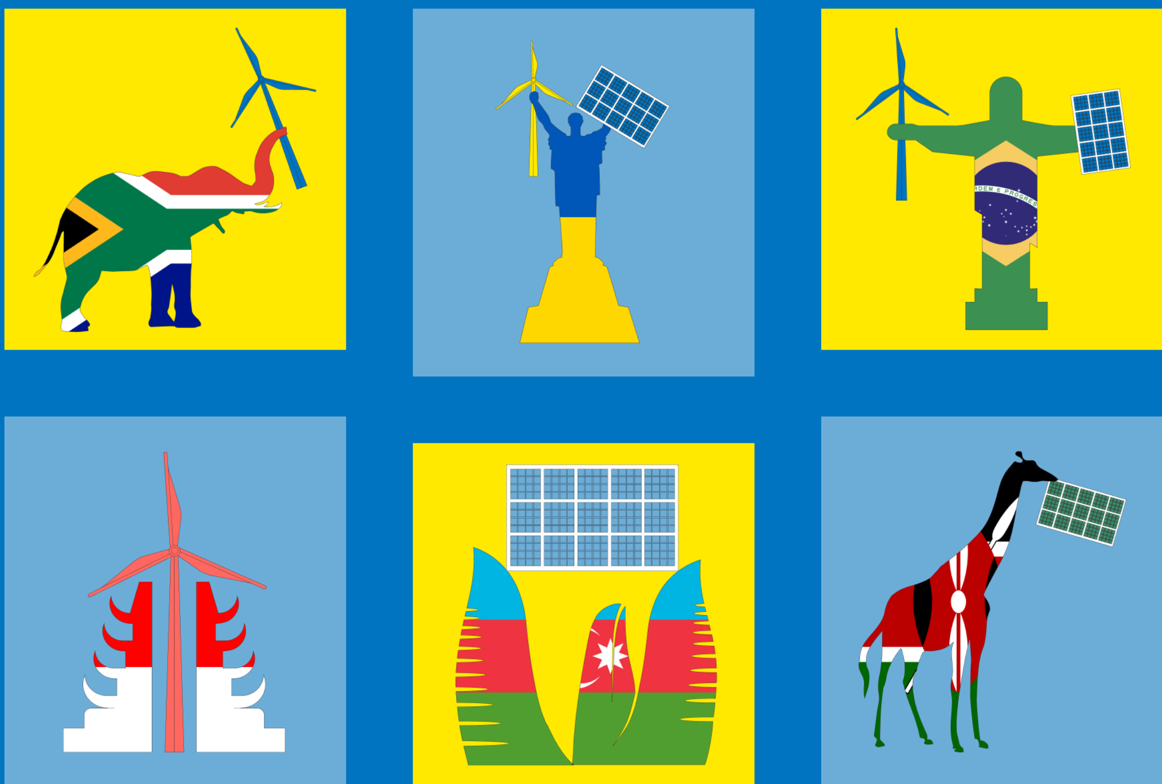
Lessons from Certain Global South Countries
in development of decentralized energy systems
and increasing end use energy efficiency:

WHAT CAN BE IMPLEMENTED IN UKRAINE?



RAZOM WE STAND

HEINRICH BÖLL STIFTUNG
KYIV
Ukraine

2024

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Ukraine

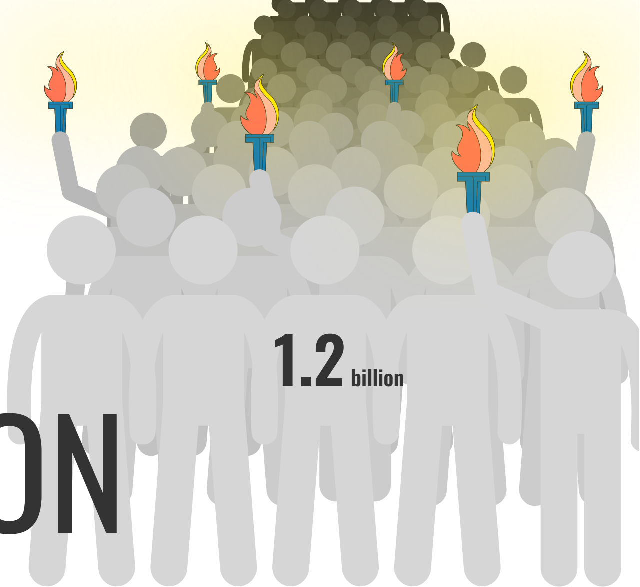
RAZOM WE STAND

Razom We Stand is a high impact advocacy group focusing on efforts to end fossil fuelled conflicts and climate chaos, and drive the clean energy revolution in Ukraine and globally.

Razom We Stand was formed in 2022 as the response to Russian aggression and as a successor to the Stand with Ukraine campaign, which has united more than 860 organizations and groups from 60 countries to fight Russia on the energy front.

We seek to build momentum for redesigning the global economy and major financial mobilization for investments into new clean, smart and efficient energy systems based on renewables.

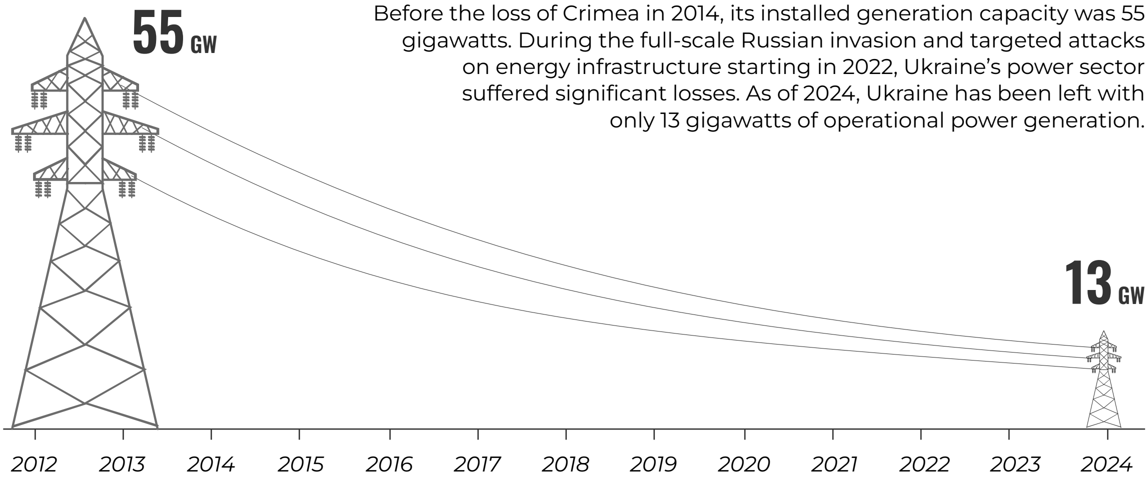
CONTENT



INTRODUCTION

More than [1.2 billion people worldwide lack access to electricity](#) in their homes. As a result, they are forced to burn expensive and polluting fuels for their basic lighting and cooking needs.

Ukraine has never been on the list of countries with electricity shortages. Before the loss of Crimea in 2014, its installed generation capacity was 55 gigawatts. During the full-scale Russian invasion and targeted attacks on energy infrastructure starting in 2022, Ukraine's power sector suffered significant losses. As of 2024, Ukraine has been left with only 13 gigawatts of operational power generation.



> **No European energy system has ever experienced or withstood such large-scale destruction, including during the First and Second World Wars.**
>
> *[Energy Charter Secretariat](#)*

Energy decentralisation is about more than just point solutions for installing individual small distributed generation facilities. This area has broad prospects for modernising the infrastructure and developing resilient local economies in Ukrainian communities. Each can become a sustainable eco-fortress that develops its own local infrastructure and creates better conditions for people and businesses.

Transitioning to renewable energy sources [also stimulates innovation and drives job creation in the renewable energy sector](#). This has a ripple effect on the local economy, creating opportunities for skilled workers and contributing to economic growth.

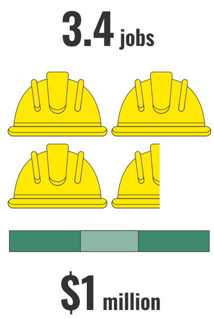
This paper will examine the possibilities that such solutions as microgrids, Energy Service Companies (ESCO) project impelementation, and decentralization of energy generation can offer for the energy future in Ukraine and targeted countries of the Global South.

Let's start with definitions of what microgrids and ESCO are.Microgrids (MGs) are integrated systems composed of distributed energy resources, local electric power network and electrical loads operating as a single system able to operate in parallel or autonomous "islanded" modes with the distribution network. Microgrids are small, modern systems that mimic today's extensive centrally dispatched power systems at a local scale. Similar to large electrical power systems (EPS), microgrids can generate, distribute, and regulate the flow of electricity to consumers.

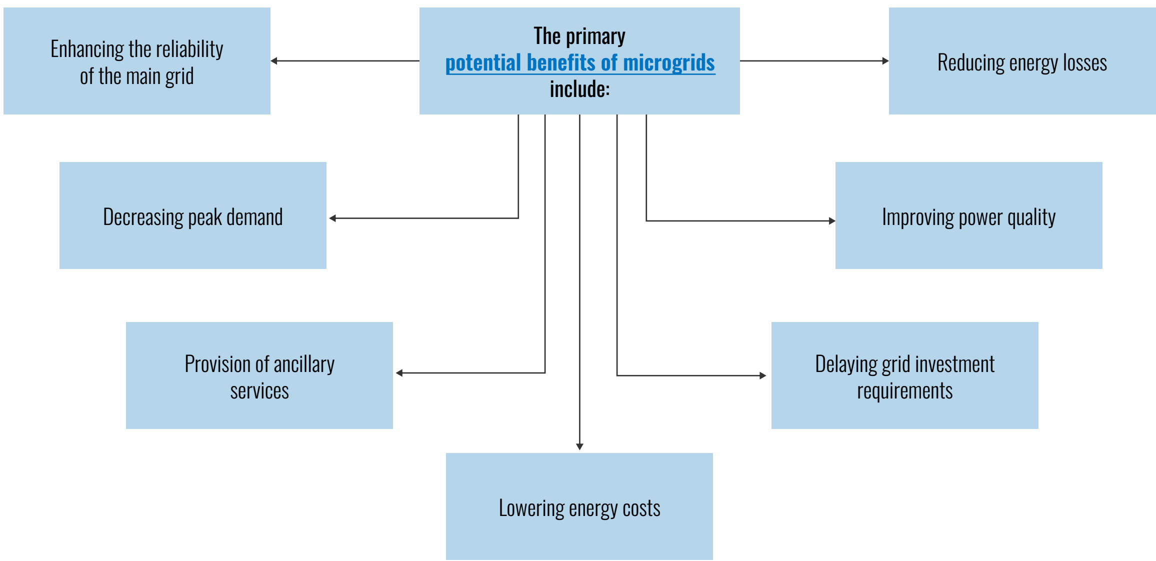
When operating in parallel, microgrids increase the main grid's capacity, reliability, and efficiency. MGs are designed to provide reliable and efficient electricity to small communities, facilities, or even individual homes. They can be powered by various energy sources, such as solar panels, wind turbines, diesel generators, or batteries

Microgrids offer several advantages over traditional main-grid technology. Traditional grid expansion, with costs ranging from $19,000 to $22,000 per km for transmission and $9,000 per km for distribution, poses significant financial costs in areas of low density. To recover these costs, utilities often need to implement cost-reflective tariffs, most of which are typically unaffordable for most rural households

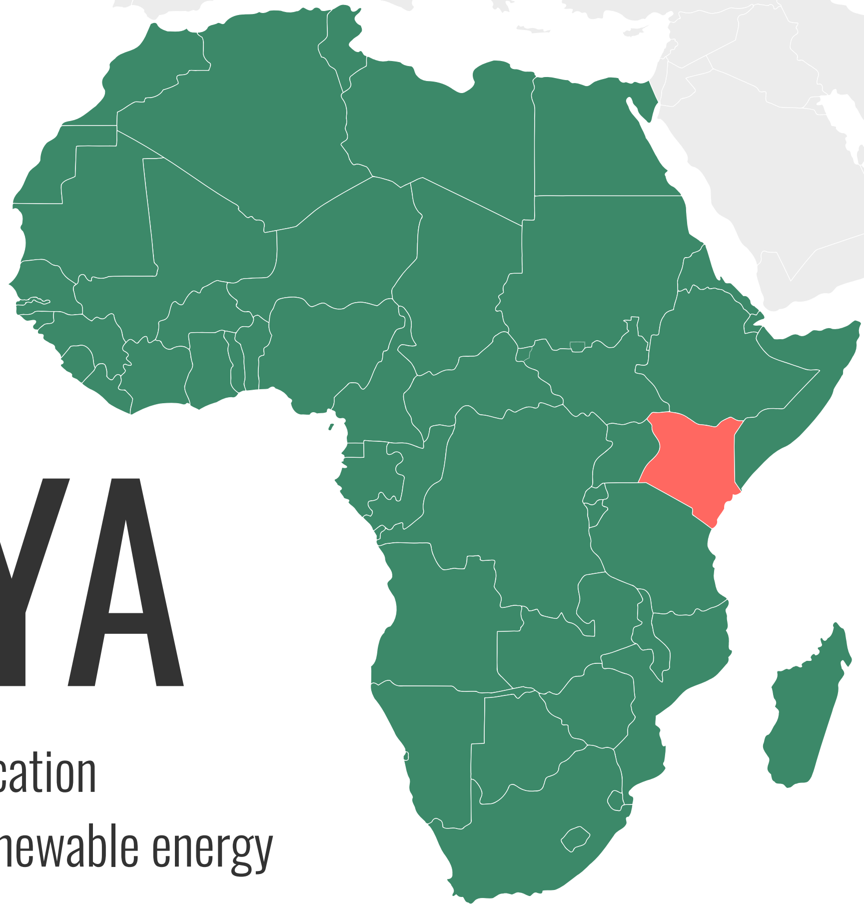
For example, nearly 500,000 new jobs will be created just from the manufacturing of components of microgrids over the next decade. Every million dollars invested in renewable energy microgrid assets creates 3.4 skilled jobs and $500,000 in additional economic benefits.



On the other hand, islanded microgrids are less capital-intensive than grid expansion in remote areas. They not only reduce the capital investment required but also mitigate the transmission and distribution costs associated with centralised grid systems. Furthermore, with renewables forming a larger proportion of off-grid energy sources, the cost of installation has fallen by an estimated 25 to 30 % since 2014.



The ESCO project implementation model was created to recapture savings from implementing energy-efficient strategies in commercial and industrial properties. ESCOs have four key operational characteristics. First, an ESCO guarantees energy savings and the delivery of the same level of energy service at a lower cost through energy efficiency projects. This performance guarantee may involve the actual energy savings from a project, ensuring that these savings cover monthly debt service costs for the project or confirming that the same level of service is provided at a reduced price. Second, the compensation for the ESCO is directly linked to the energy savings achieved, reflecting their performance. Third, an ESCO usually finances or helps arrange financing for the installation of efficiency projects by providing a savings guarantee. Lastly, an ESCO often maintains an ongoing role in measuring and verifying the savings throughout the financing period.

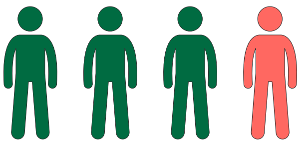


AFRICA

KENYA

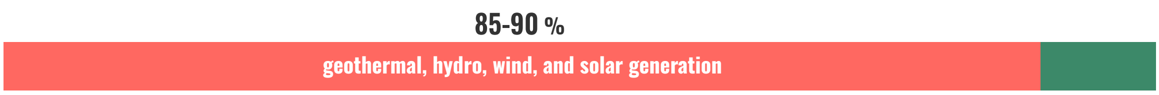
Experience in electrification using decentralized renewable energy

Brief energy profile



*Access to electricity has increased dramatically in Kenya over the past 20 years, reaching **almost 3/4 of the population today**.*

*Kenya's energy mix **predominantly consists of clean energy** with geothermal, hydro, wind, and solar accounting for 85 % to 90 % of generation in 2023, according to different estimates. The remainder is filled by biomass, HFO plants, and imports. Renewable sources are expected to replace existing thermal plants as Kenya moves towards a fully green grid by 2030.*



Kenya's experience offers an interesting case study of a developing country choosing to prioritize renewable energy over coal despite initial plans to the contrary. It demonstrates the growing global shift away from coal power, even in countries that haven't previously relied on it. Yes, Kenya had plans to build the first coal-fired power plant in Lamu, a coastal town and UNESCO World Heritage site, and this 1,050 MW project was part of the country's Vision 2030 development agenda. The proposed Lamu coal plant faced significant opposition from environmental groups, local communities, and some international organizations In 2020, the project **was effectively cancelled** when the Industrial and Commercial Development Corporation (ICDC) of Kenya announced it would not proceed with the project.

Instead of looking at fossil-fueledpower stations, Kenya has been making significant strides in decentralizing its energy sector, particularly through the adoption of renewable energy sources and off-grid solutions.

The Energy Act of 2019 provides a framework for county governments to develop energy plans and regulate electricity distribution in their jurisdictions. It also allows for net metering, enabling small-scale producers to sell excess power to the grid.

The decentralized energy supply in Kenya is provided by:

Off-Grid Solar: →

- Kenya is a leader in off-grid solar adoption in Africa.
- Pay-as-you-go (PAYG) solar home systems have seen widespread adoption, allowing rural households to access electricity without a grid connection. For example, the Azuri project has combined solar and mobile phone technology to bring clean energy to people living in Sub-Saharan Africa. The pay-as-you-go solar home system provides eight hours of emission-free lighting each day and enough power to charge mobile phones. The Azuri system cuts weekly energy spending by up to 50 %, so people start immediately saving money and reducing emissions.
- Companies like M-KOPA, d.light, and Azuri Technologies have been at the forefront of this market.

Mini-Grids: →

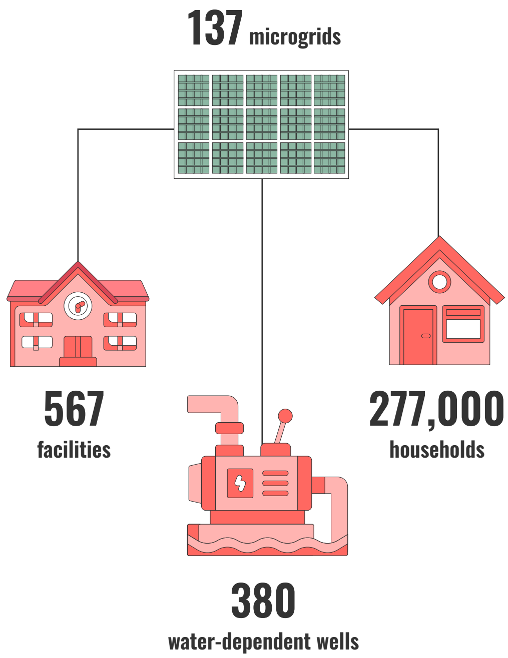
- Mini-grids are increasingly being deployed to serve rural communities. As of 2023, Kenya has about 62 mini grids that are fully operational and 28, which are under construction.
- These typically use a combination of solar PV, battery storage, and sometimes diesel backup.

The government has supported mini-grid development through initiatives like the Kenya Off-Grid Solar Access Project (KOSAP), a flagship project of the Ministry of Energy financed by the World Bank. It aims to provideelectricity and clean cooking solutions in the country's remote, low-density, and traditionally underserved areas.

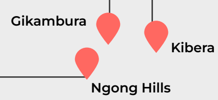
Kenya also intends to build 137 more microgrids based on solar energy to overcome the energy shortage in remote areas of the country. These projects will allow for the electrical installation of 567 facilities, including schools, hospitals, and administrative institutions. In addition, they will supply electricity to the pumps of 380 water-dependent wells. Overall, the project will provide electricity access for 277 thousand households (1.5 million persons).

While large-scale geothermal plants are centralized, there's **growing interest in small-scale geothermal applications** for local use. The government has been exploring ways to involve communities in geothermal development, particularly in the Olkaria region. The EIB has already been supporting geothermal installations in Olkaria since 1982 and is now considering further loans for a 70 MW extension of Olkaria I and a greenfield geothermal plant in the area – Akiira I.

Of course, the possibility of installing rooftop solar PV systems in urban and peri-urban areas is not neglected. This is driven by high electricity costs and improved reliability of solar technology.



Various community-owned renewable energy projects have been implemented, often with support from NGOs and international development agencies. These projects aim to provide local control over energy resources and promote sustainable development. For example:



Gikambura Solar Project

Type: *Solar*

Description: *This project involves installing solar panels in Gikambura, where community members collectively own the systems. They benefit from reduced electricity costs and improved access to energy.*

Kibera Community Youth Program

Type: *Solar*

Description: *This initiative installs solar street lights in Kibera, providing safe public spaces while engaging local youth in renewable energy training and maintenance.*

Wind Power Projects in Ngong Hills

Type: *Wind*

Description: *Community-owned wind power initiatives in the Ngong Hills area aim to harness wind energy to provide electricity to local residents, promoting renewable energy usage.*

ESCO in Kenya

The demand for ESCO services has increased due to rising energy costs, the need for sustainable practices, and government initiatives promoting energy efficiency.

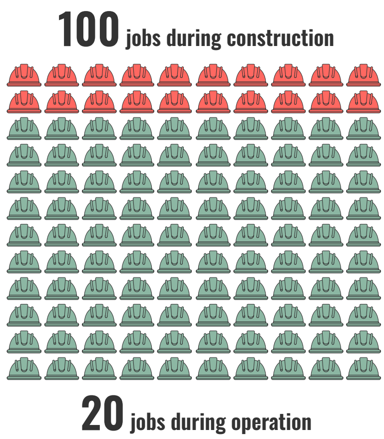
In 2021, the government of Kenya announced the creation of a Super Energy Service Company (ESCO). The Super ESCO developed and implemented energy efficiency projects for both the public and private sectors, and they were run by the Kenya Power and Lighting Company. Super ESCOs, backed by the national government, attracted leading experts in energy efficiency implementation and funding from multilateral development banks. This is one of the reasons that establishing a Super ESCO was one of the priority actions included in Kenya's National Energy Efficiency and Conservation Strategy (KNEECS).

"Green" jobs created

Microgrid implementation, as well as other projects in renewable energy, significantly contributed to job creation. Many microgrid projects include training programs for local communities, equipping them with energy management and maintenance skills.

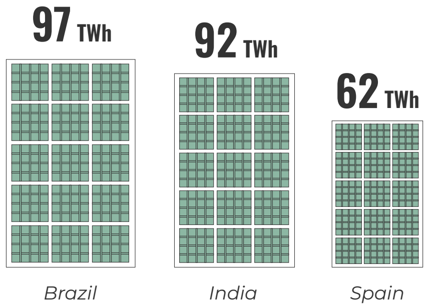
Kenya's green economy could create up to 240,000 jobs by 2030. For every 1 MW of mini-grid capacity developed, approximately 800 full-time-equivalent jobs are designed for Kenyan workers.

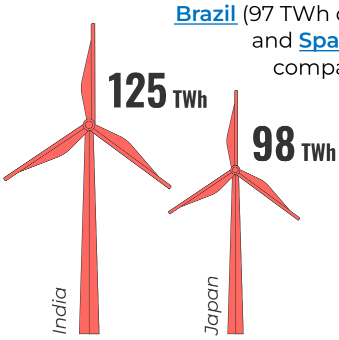
Projects like the Powerhive microgrids have reported creating approximately **120 jobs**: 100 during construction and 20 during operation.



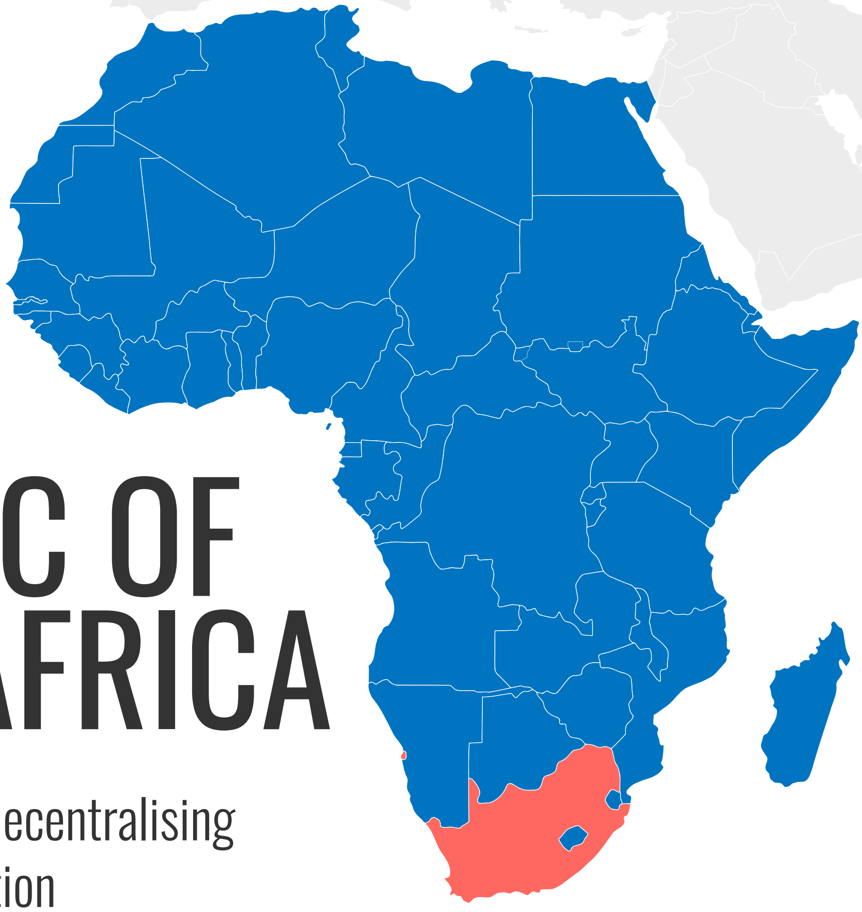
CONCLUSIONS

Kenya could expand its existing wind energy infrastructure to ramp up low-carbon electricity generation. Learning from successful countries, Kenya could take cues from Brazil (97 TWh of wind), India (92 TWh of wind), and Spain (62 TWh of wind), which have comparable economic conditions and have achieved substantial wind energy generation.



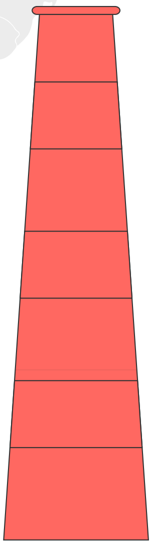


Leveraging advancements in turbine technology and attracting international investments in wind energy can replicate these successes. Investments in solar energy should also be considered, inspired by the significant contributions in countries like India (125 TWh) and Japan (98 TWh), providing a diversified and resilient low-carbon electricity portfolio.



AFRICA

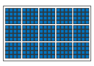
REPUBLIC OF SOUTH AFRICA



Experience in decentralising energy generation

Brief energy profile

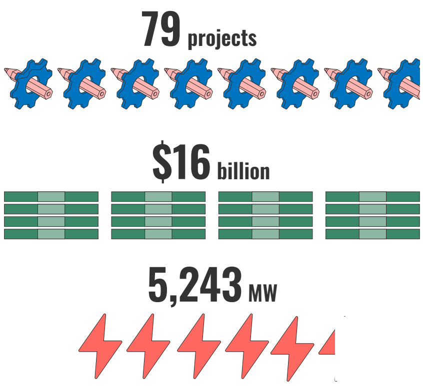
In South Africa, approximately 85 % of the nation's electricity— 42,000 MW — is generated via coal-fired power stations. Despite environmental concerns, coal will continue to provide the majority of South Africa's power for the next decade, although the share from renewables will grow rapidly. 8.8 % of South Africa's electrical energy in 2023/24 was generated from renewables.



South Africa will need about 150 GW of renewable-energy generation and associated transmission infrastructure by 2050, meaning it needs to build about 6 GW of renewable-energy capacity each year.

South Africa's experience in decentralizing energy generation has been driven by a combination of factors, including the need to address electricity shortages, reduce reliance on coal, and meet growing energy demands. Historically, South Africa's energy sector was dominated by Eskom, the state-owned utility, which relied heavily on coal-fired power plants. Approximately 95 % of the electricity used in South Africa and 45 % of the electricity used in Africa is produced by Eskom. About 45 % of all end users in South Africa receive their power straight from the firm, with the remaining 55 % being resold by redistributors (including municipalities).

Frequent power outages (load shedding) due to insufficient generation capacity and ageing infrastructure have been a major issue since 2007. In July 2024, South Africa celebrated a 100-day milestone of no power cuts, marking the longest period of energy stability in the country since 2021. South African utility Eskom also celebrated an energy availability factor of 65.5 % in April, exceptionally high compared to just three years ago.



In 2011, the South Africangovernment launched the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which marked a significant shift towards decentralized energy generation. It allows private companies to bid for renewable energy projects and sell electricity to Eskom. Since the launch of this public-private partnership, $16 billion in private-sector investment has been committed for 79 awarded projects totaling 5,243 MW of renewable energy. The program has significantly reduced tariff rates for solar photovoltaics (PV) and wind over a short period.

Government also issues another important policies and initiatives towards renewable energy and decentralisation:

Integrated Resource Plan (IRP):

The IRP outlines South Africa's energy strategy, promoting renewable energy and decentralized generation as part of the transition to a more sustainable energy mix.

Small-Scale Embedded Generation (SSEG):

Policies have been established to facilitate small-scale embedded generation, allowing individuals and businesses to generate their own electricity. Electrical generators that can connect and operate in parallel with the grid/network (by synchronising with the grid), are seen as embedded generators (EG). EG smaller than 1MVA (1000kVA) are defined as small scale embedded generators. In South Africa, solar PV is the primary technology type used as an SSEG, but wind, biogas electricity, hydropower and diesel generators connected to the grid are also forms of EG.

In addition, momentum is building to enact the 2023 Electricity Regulation Amendment Bill, which proposes a shift away from a predominantly single-buyer electricity market, currently dominated by state-owned Eskom, toward a more diverse and competitive electricity market. The bill also extends the powers of the National Energy Regulator of South Africa (NERSA).

Some municipalities aim to reduce reliance on Eskom and have been pushing for the right to procure electricity directly from independent power producers (IPPs). For example, the City of Cape Town has implemented the Small-Scale Energy Generation (SSEG) programme, which promotes the uptake of rooftop solar photovoltaic (PV) systems and small wind turbines in the commercial and residential sectors, allowing consumers to become producers and sell excess electricity generated back to the grid, fostering a more decentralised and sustainable electricity supply. The City of Johannesburg has launched a Green Energy Program aimed at encouraging the installation of renewable energy systems, particularly solar PV, in residential and commercial sectors. Ekurhuleni has developed several renewable energy projects, including solar farms, to increase local electricity generation and reduce carbon emissions.

Similar to other countries that are in the process of implementing local renewable energy projects, South Africa faces challenges regarding:

Grid Integration issues

The lack of clear interconnection standards for decentralized systems can complicate their integration with the national grid. Increasing the share of decentralized generation in the energy mix raises concerns about grid stability and reliability, necessitating advanced management solutions.

Financial barriers

Implementing renewable energy requires a large amount of investment, and many small-scale producers struggle to secure financing due to perceived risks, lack of collateral, and inadequate financial products tailored for decentralized projects.

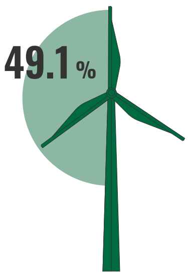
CONCLUSIONS

South Africa's experience demonstrates both the potential and challenges of decentralizing energy generation in a developing economy with a historically centralized system and Eskom’s monopoly. While significant progress has been made, particularly in renewable energy deployment, challenges remain regarding grid integration, regulatory frameworks, and managing the transition from a coal-dominated system. Traditional reliance on centralized energy systems can create resistance to adopting decentralized solutions.

SOUTH AMERICA

BRAZIL

Experience in implementing ESCO Models and Microgrids

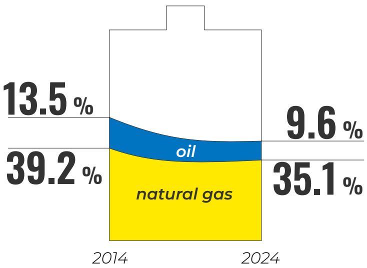


Brief energy profile

Brazil is the largest economy in Latin America and the Caribbean, the 2nd largest biofuel producer in the world, and the second-largest hydropower producer.

In 2023, Brazil achieved a significant milestone in its energy sector, with renewable energy sources comprising 49.1 % of the national energy matrix.

The share of oil and derivates dropped from 39.2 % to 35.1 %, while natural gas went from 13.5 % to 9.6 % over that 10-year period. This shift highlights Brazil's progress in the diversification and increased sustainability of its national energy supply.



In 2022, Brazil enacted Law 14300/2022, which established a legal framework for distributed generation, including provisions that apply to microgrids. Federal Law No. 14,300, of January 6, 2022, introduced substantial changes to the Energy Compensation System (SCEE) applicable to consumers with small-sized distributed generation in Brazil, which was until then governed by Normative Resolution No. 482, of April 17, 2022, of the National Electric Energy Agency (ANEEL).

The SCEE enables consumer units to participate in any compensation modalities to reduce the amount of energy consumed by energy injected into the distribution network. It was reformed under the new Law to update the requirements applicable to consumers to frame the categories of micro and mini distributed generators and of potential beneficiaries; the modalities of energy surplus compensation, the legal framework for energy credits, and the methodology for compensation for electricity consumed, with the creation of transition regimes for the incidence of new tariff components on compensated energy and changes in the application of the availability tariff on the consumer unit that is part of the SCEE and of the contracted demand on the consumer unit with micro or mini distributed generation.

Changing the existing legislation and opening up opportunities for microgrids has several advantages:

Remote areas:

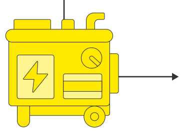
Microgrids offer potential for electrification in remote areas of Brazil, particularly in the Amazon region.

Renewable integration:

They can facilitate greater integration of renewable energy sources like solar and wind.

Grid resilience:

Microgrids can enhance overall grid resilience and energy security.



Most isolated communities in the Amazon rely on diesel generators, which produce an estimated 3 million tonnes of carbon dioxide annually - to produce a few hours of electricity per day. Thus, several microgrid projects have been implemented in the Amazon rainforest, where traditional grid expansion is challenging due to dense forests and remote locations.

Despite the potential benefits, one relevant challenge for implementing microgrids in Brazil is the **absence of consolidated guidelines and standards for operation**, **connection, and integration with existing infrastructure:** Much of Brazil's existing grid infrastructure is ageing and was not designed with microgrids in mind. Ensuring compatibility between modern microgrid technologies and older grid equipment can be complex.

Another challenge to the widespread deployment of off-grid solar is a need for more local operations and maintenance expertise. Many local projects involved training locals to maintain the equipment. For example, Vila Limeira's installation was largely completed by locals who were then trained in basic maintenance. Similarly, 100 individuals in the Xingu Indigenous Park were trained in solar installation and maintenance.

ESCO in Kenya

The Brazilian government has been supportive of ESCO development, particularly through PROCEL (National Electricity Conservation Program), which was created in 1985 and aimed at promoting energy efficiency in several economic sectors through effective energy conservation measures.

In 2018, the government launched the "Programa de Eficiência Energética" (Energy Efficiency Program), which provides a framework for ESCO operations. The common ESCO Models in Brazil are:

Shared Savings:

This model is popular as it reduces financial risk for the client. The ESCO finances the project and shares the energy cost savings with the client.

Guaranteed Savings:

The client finances the project, and the ESCO guarantees a certain level of energy savings. If savings fall short, the ESCO compensates the difference.

Energy Performance Contracting (EPC):

A comprehensive contract where the ESCO's payment is directly linked to the amount of energy saved.

The most famous cases of ESCO companies in Brazil:

Eletrobras - one of Brazil's largest state-owned energy companies, Eletrobras implemented various energy efficiency projects through its ESCO division and focused on retrofitting public buildings and promoting energy-efficient technologies in industrial facilities, contributing significantly to energy savings across the country.

Energia Sustentável do Brasil (ESBR) is involved in renewable energy projects and energy efficiency solutions, focusing on sustainability and reducing carbon emissions and has worked on wind and solar energy projects, as well as energy efficiency initiatives to optimize energy use in various sectors.

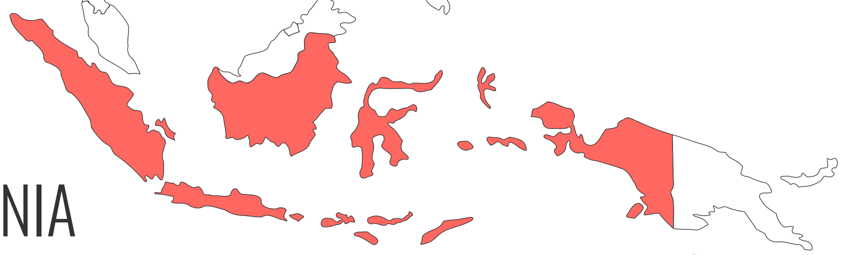
Tractebel is focusing on energy efficiency and renewable energy projects and has engaged in various initiatives, including energy audits for industrial clients and implementing energy-efficient systems in buildings.

CPFL Energia - has developed an ESCO division dedicated to offering energy efficiency solutions to residential and commercial clients.

CONCLUSIONS

The Brazilian ESCO market has been growing, with an increasing number of both domestic and international ESCOs operating in the country. ABESCO (Brazilian Association of Energy Conservation Service Companies) plays a crucial role in promoting the ESCO industry and providing training and certification. The trend of integrating renewable energy solutions into ESCO offerings should be considered investment-attractive.

Overcoming challenges in implementing microgrids requires a coordinated effort from policymakers, regulators, utilities, technology providers, and microgrid operators. It also necessitates ongoing research and development to create innovative solutions that can bridge the gap between existing infrastructure and the potential of microgrid technology in the Brazilian context.



ASIA AND OCEANIA

INDONESIA

Experience in introducing alternatives to Coal-Fired Power Plants and implementing Microgrids

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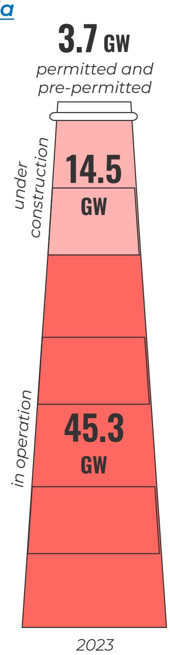
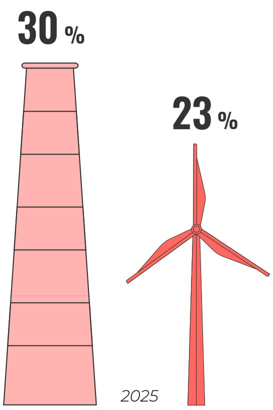
Brief energy profile

As of 2023, the total electricity produced from coal in Indonesia accounted for around 62 % of the nation's electricity mix. Coal plays a vital role in Indonesia's electricity sector, and the Indonesian government perceives it as the cheapest energy source for electricity compared to other fossil fuels and renewable energy sources.



Phasing out the use of unabated coal power will play a crucial role in decarbonizing Southeast Asian economies. As of July 2023, Southeast Asia had about 106 GW of active coal-fired power capacity and another 40 GW in the pipeline.

Indonesia has the largest coal power fleet in Southeast Asia. As of July 2023, it had 45.3 GW in operation, 14.5 GW under construction, and 3.7 GW permitted and pre-permitted.



Indonesia has indicated its desire to move away from coal and towards renewable energy and to achieve net-zero emissions by 2060 in its Long-Term Strategy for Low Carbon and Climate Resilience (LTR-LCCR). The National Energy Plan outlines Indonesia's long-term energy strategy, emphasizing a shift towards renewable energy sources. The aim is to achieve an energy mix of at least 23 % renewable energy and a maximum of 30 % coal by 2025.

Indonesia's energy ministry (ESDM) identified 13 coal-fired power plants to be retired before 2030 as part of the country's efforts to cut emissions in line with its net-zero goals based on multiple factors such as economic life, electricity production offtake, and emission levels in relation to electricity produced, the ESDM said. The units have an estimated total capacity of 4.8 GW and collectively produce roughly 48 mn t of CO_2 equivalent (CO_2e).

At the same time, Indonesia has enormous opportunities for the development of renewable energy projects:

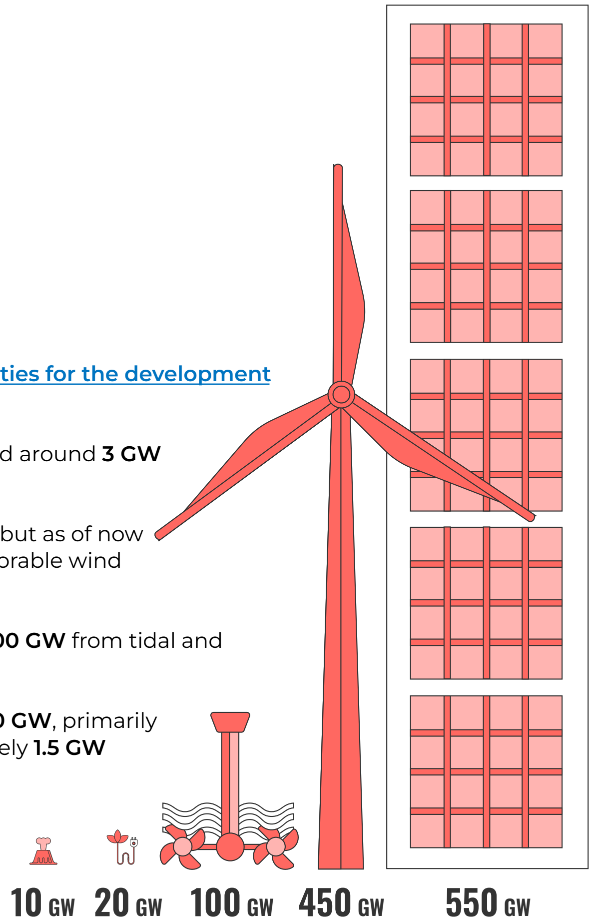
Solar Energy - estimated potential approx. **550 GW** and around **3 GW** have been installed.

Wind Energy has potential of approximately **450 GW**, but as of now limited capacity is deployed primarily in areas with favorable wind conditions at about only **0.2 GW**.

Ocean Energy has an estimated potential of around **100 GW** from tidal and wave energy resources.

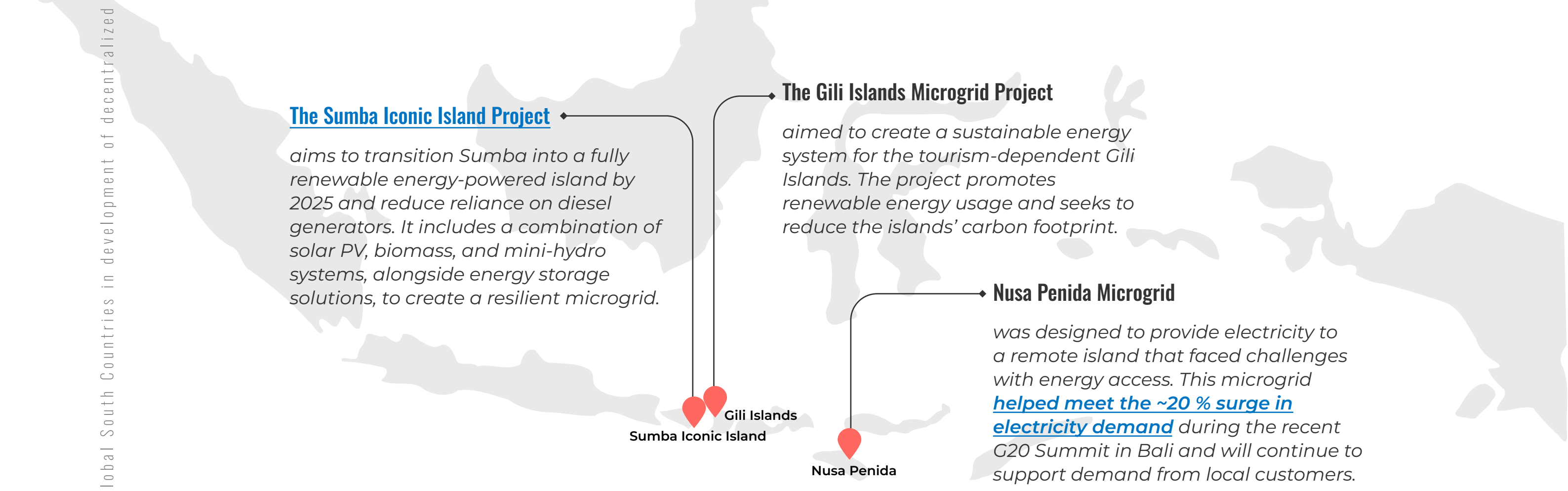
Biomass and Bioenergy have a potential of roughly **20 GW**, primarily from agricultural residues and waste, with approximately **1.5 GW** already developed.

Geothermal Energy has an estimated economically achievable potential of around **10 GW**, with **2.2 GW** currently operational making Indonesia the largest geothermal producer in the world.



The utilisation and development of renewable energy are regulated mainly under Indonesian Law No 30 of 2007 on Energy (the "Energy Law") as well as Indonesian Law No 30 of 2009 on Electricity (as amended) (the "Electricity Law"). The Energy Law requires the Indonesian central and local governments to (i) increase the utilisation of renewable energy and (ii) provide incentives for clean energy developers. Further, Government Regulation No. 79 of 2014 on the National Energy Policy sets out the Indonesian government's national renewable energy sources targets as part of its national energy mix.

In 2023, Indonesia's electrification rate was 99.78 %. The government targets a 100 % rate by 2024. Increasing the electrification ratio always becomes challenging because Indonesia has more than 17,000 islands and many isolated communities. Thus, Indonesia has increasingly adopted microgrid projects to improve energy access, particularly in remote and rural areas.



The Sumba Iconic Island Project

aims to transition Sumba into a fully renewable energy-powered island by 2025 and reduce reliance on diesel generators. It includes a combination of solar PV, biomass, and mini-hydro systems, alongside energy storage solutions, to create a resilient microgrid.

The Gili Islands Microgrid Project

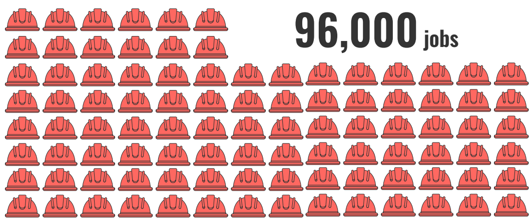
aimed to create a sustainable energy system for the tourism-dependent Gili Islands. The project promotes renewable energy usage and seeks to reduce the islands' carbon footprint.

Nusa Penida Microgrid

was designed to provide electricity to a remote island that faced challenges with energy access. This microgrid ***helped meet the ~20 % surge in electricity demand*** *during the recent G20 Summit in Bali and will continue to support demand from local customers.*

These microgrid projects demonstrate Indonesia's commitment to improving energy access and sustainability through localized renewable energy solutions. By leveraging its abundant renewable energy potential and fostering community engagement, these initiatives can significantly enhance the quality of life for residents in remote areas.

“Green” jobs creation



Indonesia has the potential to create 96,000 jobs by expanding its clean power capacity and reducing reliance on fossil fuels. The country can meet its 2030 electricity demand without new coal plants by increasing the efficiency of current coal plants.

ESCO companies and their impact

The number of companies operating as ESCOs can vary, but estimates suggest there are approximately 20 to 30 active ESCOs in the country. Four largest ones are:

PT. Energi Baru Technology (EBT) has implemented energy-saving projects in various sectors, including commercial buildings and industrial facilities, often involving retrofitting lighting and HVAC systems.

PT. Schneider Electric Indonesia provides comprehensive energy management and automation solutions.

PT. Surya Energi Indotama specializes in solar energy solutions and energy efficiency projects.

PT. Kencana Energi Lestari has undertaken projects that incorporate energy audits, efficiency improvements, and renewable installations for various industrial clients.

CONCLUSIONS

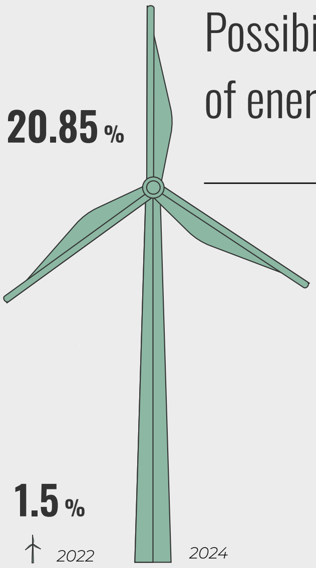
The implementation of microgrids and ESCOs for power supply in Indonesia represents a significant opportunity to enhance energy access, promote sustainability, and drive economic growth. These systems help diversify the energy mix, reducing reliance on fossil fuels and enhancing energy security.

ESCOs enable businesses and institutions to reduce energy costs through efficiency improvements, while microgrids can lower residents' electricity expenses. Building local capacity and expertise in managing microgrids and energy efficiency technologies is essential for long-term sustainability.

ASIA AND EUROPE

AZERBAIJAN

Possibilities for decentralisation of energy generation



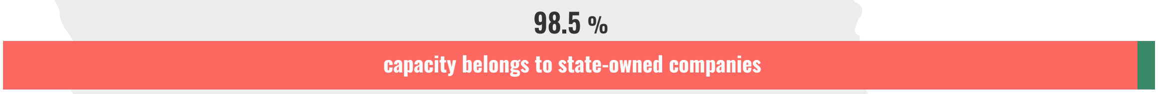
Brief energy profile

*Gas is the primary source of energy for electricity production in Azerbaijan. In 2022 approximately 5.5 % of total electricity generation was sourced from hydro. By comparison, wind sources accounted for almost 0.5 %. Azerbaijan is among the 30 **largest producers of natural gas worldwide.***

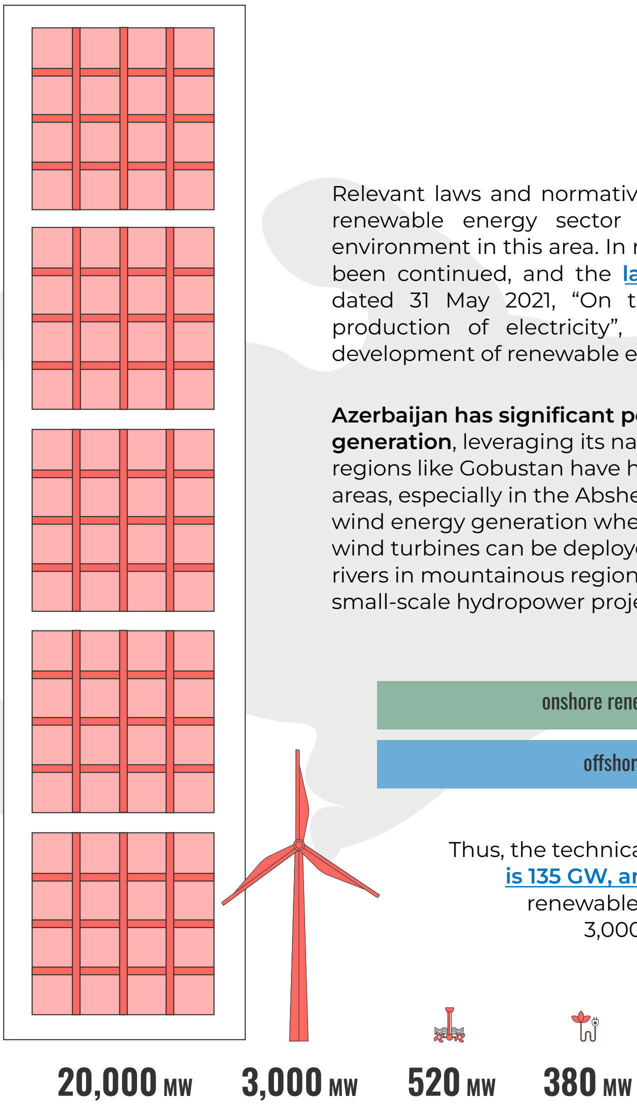
*Renewable energy sources, including hydro, contributed 1.5 % to the total energy supply in 2022 and 6 % (1.8 TWh) to the electricity supply. As of 2024, the current share of **renewables is 20.86 %**.*

Azerbaijan holds **significant natural gas reserves**, particularly in the Shah Deniz field, one of the world's largest gas fields. While fossil fuels dominate the economy, Azerbaijan increasingly focuses on diversifying it and investing in renewable energy sources. Decentralized energy generation can reduce reliance on centralized fossil fuel power plants, enhancing energy security and reliability, especially in remote areas.

However, today, **state-owned companies continue to dominate the electricity sector**. The leading market players are two vertically integrated monopolies — Azerenergy and Azerishiq. Established in 1996, Azerenergy became the umbrella for all energy enterprises in the country. Currently, Azerenergy is the primary grid operator electricity generator in Azerbaijan. In total, 98.5 % of all installed capacity belongs to state-owned companies and 1.5 % is owned by the private sector.

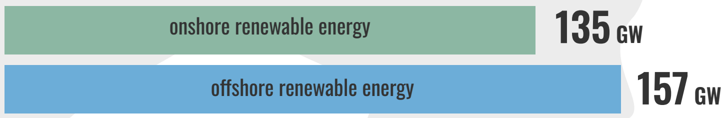


Azerbaijan's government has outlined its energy strategy to increase renewable power capacity **to 30 % of its energy mix**. It aims to achieve a substantial portion of its electricity generation from renewable sources by 2030 and become a leader in green energy.



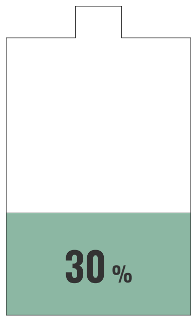
Relevant laws and normative legal acts have been adopted to develop the renewable energy sector to improve the legislative and institutional environment in this area. In recent years, the work carried out in the field has been continued, and the law of the Republic of Azerbaijan No 339-VIQ, dated 31 May 2021, "On the use of renewable energy sources in the production of electricity", which makes a special contribution to the development of renewable energy has been approved.

Azerbaijan has significant potential for decentralization of energy generation, leveraging its natural resources and strategic location - regions like Gobustan have high solar insolation, and coastal areas, especially in the Absheron Peninsula, show promise for wind energy generation where small and medium-sized wind turbines can be deployed in local communities and rivers in mountainous regions provide opportunities to small-scale hydropower projects.



Thus, the technical potential of onshore renewable energy sources is 135 GW, and offshore is 157 GW. The economic potential of renewable energy sources is estimated at 27 GW, including 3,000 MW of wind energy, 20,000 MW of solar energy, 380 MW of bioenergy potential, and 520 MW of mountain rivers.

For the sake of fairness, it is worth noting that Azerbaijan **has** launched **the country's biggest renewable energy investment project**: the construction of two solar plants and a wind power plant. This marks a major step in Baku's ambitious plan to generate 30 % of its power needs via renewable sources by 2030. However, Baku's motivation is not entirely green or altruistic. Azerbaijan depends on oil and gas exports for as much as 95 % of its export revenue, a situation expected to stay the same for the foreseeable future. The country's renewable energy strategy will not only help in the "greening" of the Azerbaijani power sector, but it will also make gas currently used to generate Azerbaijan's power available for export. That means extra revenues for state coffers.



The decentralisation process was also launched with the support of international partners. Within the framework of cooperation between the Ministry of Energy of the Republic of Azerbaijan and the German Energy Agency (dena), the project "Cooperation between the Ministry of Energy of the Republic of Azerbaijan and dena in Promotion of decentralized energy supply proposing selected renewable energy application areas for the Republic of Azerbaijan" was implemented. This project helped to put in place pilot project proposals on the application of Solar PV-powered water pumps for sub-artesian wells, Mobile PV+Battery power systems, Combined solar PV and heat pump systems for greenhouses, and Biomass energy for heat in buildings.

But despite the excellent opportunities thats Azerbaijan has in renewable energy and decetralization:

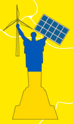
Azerbaijan's power system is interconnected with those of Russia, Georgia, Iran, and Turkey on the Nakhchivan border. However, the electricity system is synchronized only with Russia's, as Azerbaijan was previously part of the USSR's grid. Currently, Azerbaijan is not able to constantly stabilize its grid without a connection to Russia.

Currently, applied tariffs are a major hindrance to renewable energy development. These tariffs are too low, bringing insufficient incentives for foreign investors. Azerbaijani tariffs or utilities are much lower than in the world, which means they are heavily subsidized.

The government does not want to be the main producer and investor anymore; therefore, the process of unbundling and introducing feed-in tariffs should be reinforced to attract private investors.

CONCLUSIONS

The research on decentralization, microgrids, and ESCO models in Azerbaijan didn't give much hope. The ESCO market in Azerbaijan is still developing, and several companies and initiatives are laying the groundwork for enhancing energy efficiency and promoting renewable energy. The energy governance of Azerbaijan is highly centralized, and the state holds a monopoly in the energy market.

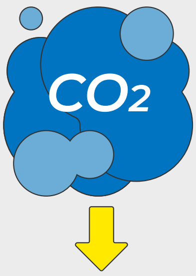


EUROPE

UKRAINE

Analysis of the current situation in energy sector and the challenges it faces

Brief energy profile

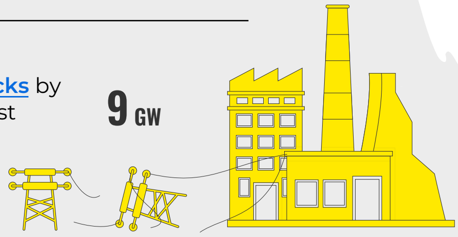


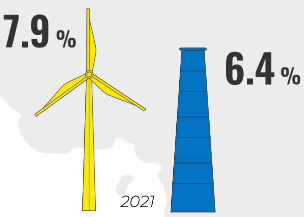
10.3
million tonnes

In 2019, [Ukraine entered the TOP-10 countries in the world] in terms of renewable energy development, and in 2020 - the TOP-5 European countries in terms of solar energy development. Again, in 2019, the Climatescope rating by Bloomberg New Energy Finance (Bloomberg NEF) ranked Ukraine 8th (up from 63rd) among 104 countries in terms of the country's investment attractiveness in the deployment of low-carbon energy sources and the development of a green economy.

Thanks to the successfully implemented renewable energy projects in Ukraine, annual CO_2 emissions into the atmosphere were reduced annually by more than 10.3 million tonnes as of 2021, equivalent to the emissions from more than 2.2 million cars. For example, electricity generated by industrial wind farms alone saved 1.8 million tonnes of coal and 1,171.4 thousand m^3 of natural gas in 2021 and reduced approximately 3.1 million tonnes of CO_2 emissions.

The Ukrainian energy sector was first subjected to massive attacks by the Russian occupiers in the autumn and winter of 2022. The latest massive Russian missile strikes and drone attacks hit the energy infrastructure in the spring of 2024. As a result, according to the Ukrainian government, in 2024, Russia destroyed more than 9 GW of electricity generation capacity.





During the war, the Russians damaged or destroyed all major Ukrainian thermal power plants: according to Ukrenergo, their share in production is now barely 5 %.

In 2021, the share of renewable energy (solar, wind, and biopower plants) was 7.9 %. Combined heat and power plants generated 6.4 % of electricity in 2021. There are 43 combined heat and power plants (CHPPs) in Ukraine, including 10 in the occupied territory.

According to the latest data, 80 % of CHPPs were destroyed due to the attacks. Hydroelectric power plants generated 5.8 % of electricity, with another 0.8 % coming from pumped storage plants. A year ago, Russian forces completely destroyed Kakhovka HPP. All major hydroelectric power plants have been damaged, including the Dnipro hydroelectric power plant.

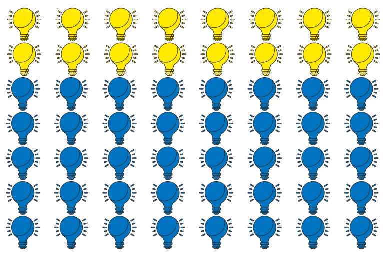
According to the IMF, Ukraine's average electricity deficit in 2024 will be about 10 %. The National Bank of Ukraine estimates 7 %, assuming no new shelling. However, in the winter of 2024-2025, the electricity deficit is expected to be up to 35 %. For 2025, the deficit is forecast at 7-10 %, with a gradual decline by the end of the year.

Given the constant threat to the unified energy system and the constant losses of centralised generation such as TPPs (DTEK, Centrenergo) and CHPs (Kharkiv, etc.), it is critical to consider restructuring the centralised energy supply system and **building a new energy supply architecture** based on decentralised/ distributed networks and alternative energy sources.

According to KSE findings, the total recovery needs of the energy sector are preliminarily estimated at $56 billion, of which the direct losses of the Ukrainian energy sector amount to over $16.1 billion and indirect losses are estimated at almost $40.1 billion. The most significant losses were caused by the destruction of power generation facilities ($8.5 billion) and grid insfrastructure associated with main power transmission lines ($2.1 billion).

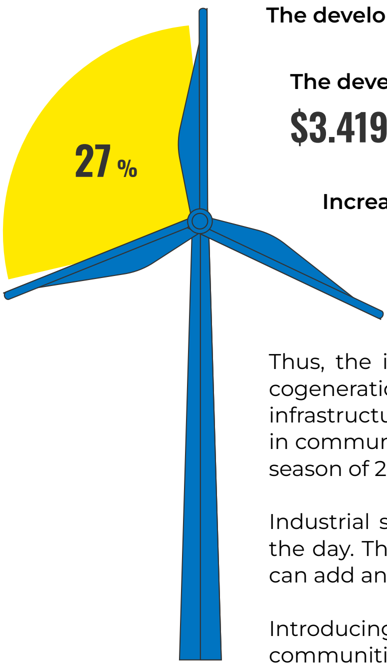
Investments in solar and wind farms create jobs in manufacturing, installation, maintenance, research, and development. The decentralized nature of renewable energy projects stimulates local economies and can revitalize rural communities.

$16.1 biilion to recovery of direct losses



$40.1 biilion to recovery of indirect losses

To increase the share of energy produced from renewable energy sources in the structure of Ukraine's gross final energy consumption in 2030 to at least 27 %, the following is required:



The development of renewables in electricity production **$12.6 biilion**

The development of RES in heating and cooling systems **$6.7 biilion**

$3.419 bilion of which is used to develop heat-generating capacities from RES

Increase the use of energy from RES in the transport sector **$1.25 biilion**

Regulatory and organisational support for RES development

Thus, the implementation of alternative energy projects and the installation of cogeneration units and gas turbines to balance consumption peaks at critical infrastructure facilities, namely heat and water utilities, as the primary consumers in communities, will help to pass the summer consumption peaks and the heating season of 2024-2025.

Industrial solar power plants generate around 3 GW, supporting our grid during the day. Thanks to an increased rate of deployement of individual solar plants, we can add another 1 GW in a short time.

Introducing microgrids to balance electricity production and consumption in communities will help reduce dependence on centralised power generation facilities. Although this will not fully guarantee the security of supply at the local and regional levels, it will increase the resilience of the entire energy system at the national level.

WHICH LESSONS FROM GLOBAL SOUTH COUNTRIES CAN BE IMPLEMENTED IN UKRAINE?

Despite Ukraine's current state of war, valuable lessons from the experiences of Global South countries in deploying renewable energy sources and building decentralizing energy systems can and should be implemented. Public-private partnerships, governmental support, and strong policy frameworks should definitely be the first steps toward meeting the country's changes.

Favourable conditions for local and international businesses to invest in the deployment of decentralised power generation are essential for replacing centralized coal power plants. Governments can create certainty and build investor confidence by setting timelines for phasing out coal.

Decentralisation of energy supply is only possible with the active involvement of the local population. Government can foster accelerated deployment of new technologies by encouraging local communities to participate in energy planning and decision-making processes. This can enhance ownership and ensure that projects meet local needs. Establishment of energy cooperatives can allow communities to co-invest in and participate in managing local energy resources. In countries like Kenya, community-based solar projects have empowered locals, allowing them to operate and maintain their energy systems. Ukraine can adopt similar approaches, encouraging community involvement in renewable energy initiatives - this fosters ownership and ensures that the energy solutions meet the specific needs of the community.

Mix of diverse energy sources can provide stable supply. Countries like Brazil and South Africa have diversified their energy sources by leveraging local resources, such as wind, solar, and biomass. This not only enhances energy security but also reduces dependence on single sources. As we saw from chapter 1, Ukraine has significant potential for renewable energy—primarily wind and solar. By continuing to promote a diversified mix of energy sources, Ukraine can create a more resilient energy system that will be more resistant to Russian attacks.

Microgrid Development can both meet the local demand and reinforce the main grid. Microgrids have been successfully implemented in many Global South countries to provide electricity to remote areas. As a result, microgrids emerge as a practical electrification solution for approximately **45 % of Africa's rural communities**. These systems can operate independently or in conjunction with the primary grid. Ukraine has already taken the first steps towards microgrid implementation by adopting changes to relevant national legislation.

Innovative Financing Models can accelerate deployment of new power generation capacities and modernisation of grids. Many Global South countries have developed innovative financing models, such as pay-as-you-go solar systems (Kenya), which allow users to pay for energy incrementally. The **PAYG business model is an innovation** that emerged to address the energy access challenge and to provide electricity generated from renewable energy sources at affordable prices, with payments facilitated by technologies available in these areas. Widespread use of mobile payment technologies, rich solar resources, decliningg solar PV and battery costs, and increased awareness of these technologies have been key drivers in implementing this business model in Kenya. Ukraine could explore innovative financing mechanisms to encourage investment in renewable energy projects, making these technologies more accessible to a broader population.

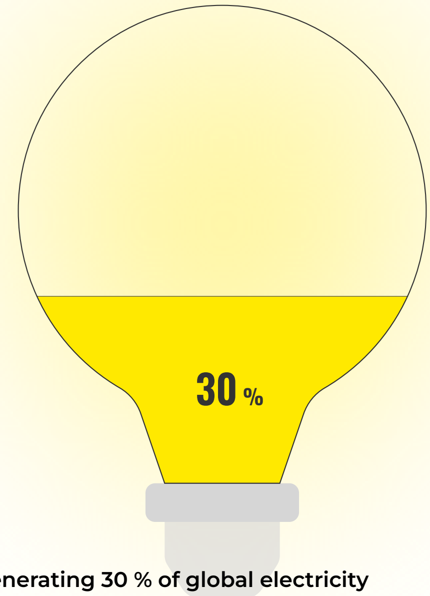
When considering the pathways for decentralization of its energy system, Ukraine needs to learn from the experience of the Global South and recognize strategies that may not be suitable for its unique context. Here are some lessons that should be approached with caution or avoided altogether:

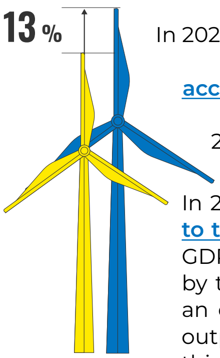
Neglecting Grid Integration. Implementing decentralized power generation technologies without proper integration with the national grid is a very big risk. When analysing all the selected countries, we saw that technical issues and integration challenges in the outdated systems are a common feature. This can lead to inefficiencies and instability in energy supply. A fragmented approach might exacerbate existing energy challenges. Ukraine should ensure that decentralized systems complement and integrate with the national grid to enhance its overall stability and efficiency.

Short-Term Solutions Over Long-Term Planning. Of course, not all countries have problems with access to electricity. However, the focus on quick-fix solutions to address energy access, while neglecting long-term sustainability and infrastructure development, can be a threat to strategic goals of energy independence and investment. Significant destruction of Ukraine's energy system as a result of the war may mistakenly require quick solutions. Quick solutions provide temporary relief but could undermine long-term energy security. Ukraine should focus on comprehensive planning for development of a decentralised energy system that promotes sustainable development and infrastructure investment.

Insufficient Capacity Building. Some projects in the Global South have failed due to a lack of local capacity and training for maintenance and operation of new assets and systems. Instead of solely relying on external expertise, Ukraine should invest in local training programs to build a skilled workforce capable of managing decentralized energy systems effectively. First and foremost, this will help bring people back to Ukraine and increase the number of green jobs.

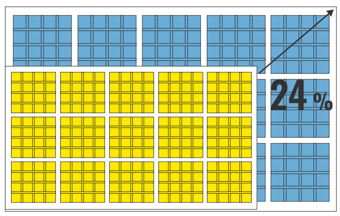
CONCLUSIONS





In 2023, **renewable energy reached a pivotal moment, generating 30 % of global electricity** and underscoring the accelerating energy transition. Globally, in 2023, solar and wind accounted for a record 12 % of global electricity generation, with solar alone contributing 5 %. This growth in renewables is pivotal, considering global electricity demand rose by 2.5 %. Notably, solar power capacity grew by 24 %, while wind power saw a 13 % increase.

In 2023 clean energy contributed around $320 billion to the world economy. This represented 10 % of global GDP growth – equivalent to more than the value added by the global aerospace industry in 2023, or to adding an economy the size of the Czech Republic to global output. This growth rate is explained, among other things, by modernizing energy systems and implementing local microgrids projects in different countries.



Decentralization of energy systems can be challenging especially in countries with established monopolies in the energy sector, and for its succes requires a transformative approach that shifts the focus of investments from large, centralized power plants to smaller, localized energy systems.

Energy system planning is essential to ensure its stable and reliable functioning, as experience shows that grid reliability can be a big issue in developing countries, such as Brazil, where the distribution networks are mostly congested, with long feeders, voltage regulation issues and many outages during the year.

The principal advantage is that decentralized energy systems are less vulnerable to large-scale outages caused by natural disasters, equipment failures, military hostilities or cyberattacks. If one part of the decentralized system fails, others can continue to operate, ensuring a more stable energy supply.

What is even more important is that decentralization often involves the use of renewable energy sources like solar, wind, and biomass, which can be locally sourced and **reduce reliance on imported fossil fuels** that fuel war and dictatorship regimes.