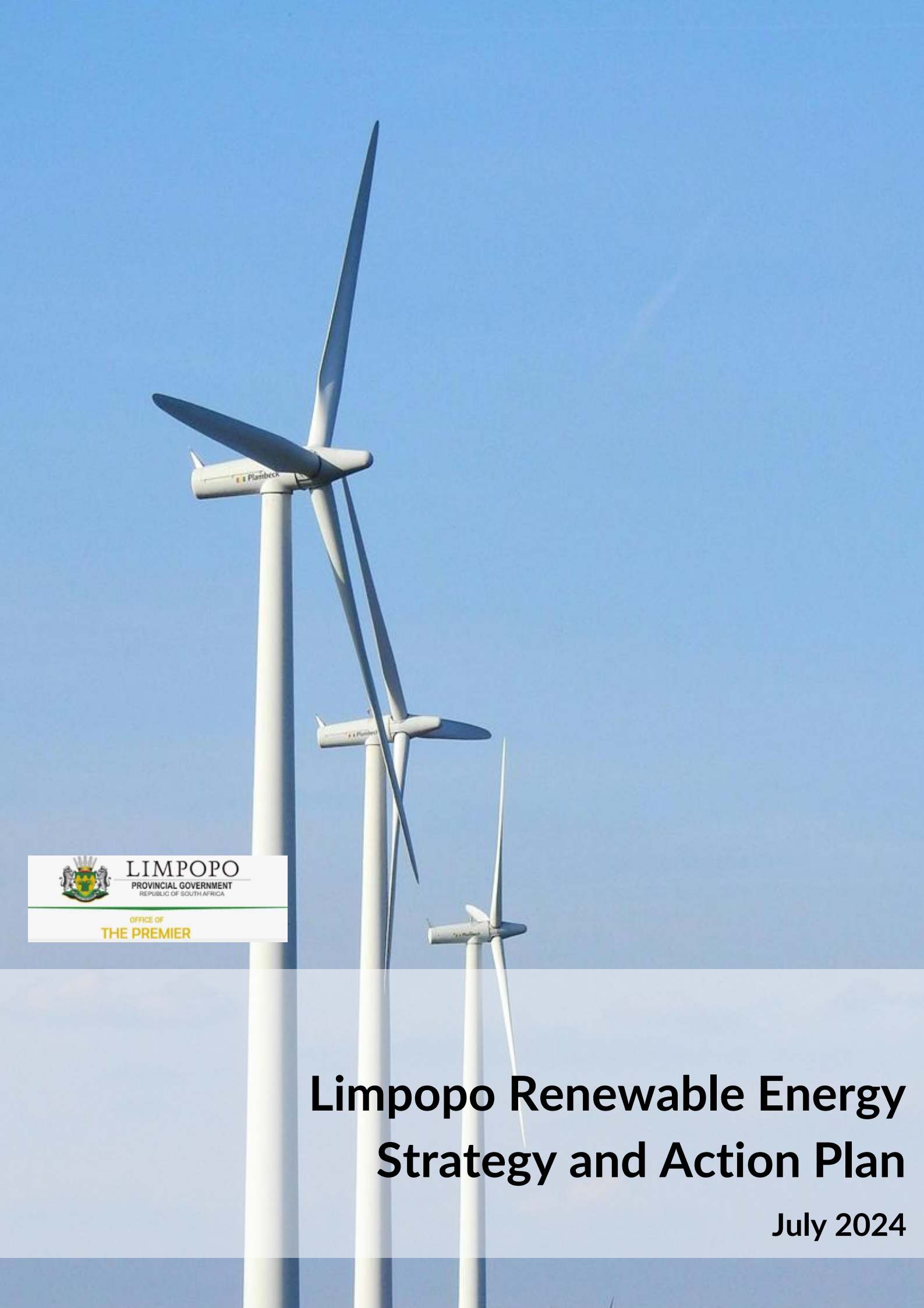

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA
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THE PREMIER

Limpopo Renewable Energy Strategy and Action Plan

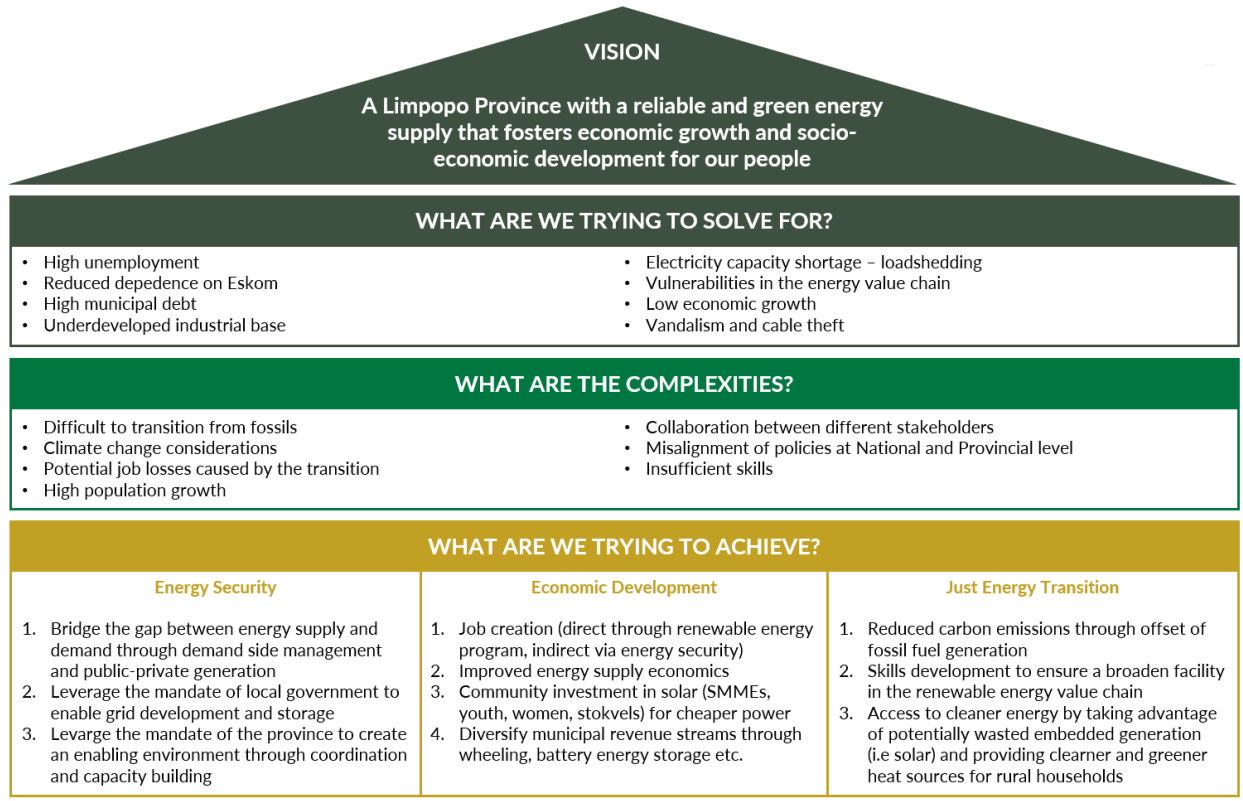
July 2024

EXECUTIVE SUMMARY

The global shift towards renewables presents a significant opportunity for South Africa, with Limpopo ideally positioned to capitalize. Abundant solar and in some instance biomass resources offer the potential for sustainable growth and a more liberalized energy sector. However, transitioning from coal requires careful planning to manage social and economic impacts.

This strategy recognises the need to balance economic development with environmental and social considerations. It outlines a path for harnessing Limpopo's renewable energy potential while mitigating challenges associated with the energy transition. This proactive approach aims to secure a resilient, equitable, and prosperous future for the province.

The vision is to achieve energy security for robust economic growth within the province whilst ensuring a just transition as indicated in the figure below. This is accompanied by complex challenges including high unemployment, grid constraints and underdeveloped industrial bases. To overcome these challenges, there is a need to bridge the gap between supply and demand by focusing on sustainable supply. This will involve several initiatives, including enhancing the role of municipalities and promoting community involvement in solar power.



Summary of the renewable energy strategy

Energy Needs Assessment

Limpopo faces a dynamic landscape when it comes to its projected electricity demand. Eskom's Transmission Development Plan suggests peak demand is expected to reach 5 069 MW by 2032. Notably, Phalaborwa, Polokwane, and Lephalale are predicted to experience significant demand increases due to various factors including electrification, mining activities, and commercial development.

Strong Limpopo economic expansion, as per the LDP scenario of 2%, could lead to a significant increase in electricity demand to 46.92 TWh by 2050. While moderate assumptions lead demand to increase to 36.97 TWh by 2050. However, rising inflationary pressure could dampen economic activity and consumer spending on electricity, potentially requiring downward adjustments to these forecasts.

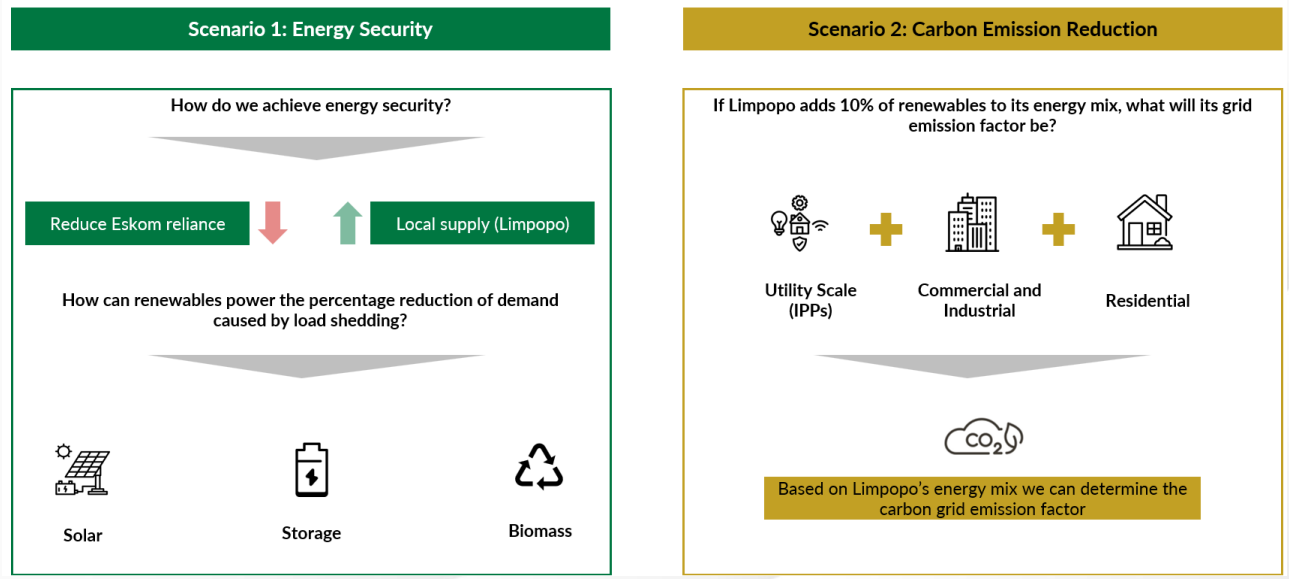
Widespread electrification is expected to eliminate firewood dependency for heating purposes. Demand for firewood is expected to decrease to zero by 2047 under the low GDP growth scenario. With the high scenario of 1.5% growth showing demand going to zero by 2044 while the LDP scenario of 2% shows demand for firewood use, going to zero by 2043. Projections can be found in Section 5 of this report.

Intervention Strategy

Recognising the uncertainties surrounding the country's coal fleet, the strategy prioritizes a diversified approach, exploring the potential of various renewable energy sources with solar and biomass proving to be the preferred options to address the two scenarios as indicated in the figure below:

- Scenario 1: This scenario is in response to the ongoing challenges of an unreliable national power grid and frequent load shedding. This scenario focuses on harnessing the abundant solar resources through extensive infrastructure, investing in advanced energy storage technologies and exploring the potential of biomass energy from organic waste.

- Scenario 2: This scenario focuses on carbon emission reduction. The province aims to incorporate renewable energy sources into its existing energy mix. This strategic shift towards cleaner energy sources is expected to impact Limpopo's carbon grid emission factor.



Overview of Scenario 1 (Energy security) and Scenario 2 (Carbon emission reduction)

Energy modelling identified a potential national energy deficit that would occur unless additional generation capacity is built. Limpopo's projected share of the shortfall is 10%, highlighting the need for strategies to reduce reliance on the national grid. To achieve this, the province will require 1 500 MW of renewable energy capacity by 2030, with solar power playing a key role. A solar build of 1 300 MW is targeted by 2027, with an additional 200 MW to come online by 2030. However, a crucial element for reliable renewable energy integration is dispatchable capacity, the ability to deliver power on demand. The plan proposes a large-scale Battery Energy Storage System (BESS) with a target of 7 200 MW by 2027.

While battery storage holds immense potential, achieving such a high BESS capacity within this timeframe might be challenging. To address this, it must be acknowledged that there is a need to explore alternative storage options alongside BESS. These alternatives include utilizing natural gas, pumped storage hydropower and buying power back from the national grid during peak hours through the NTCSA.

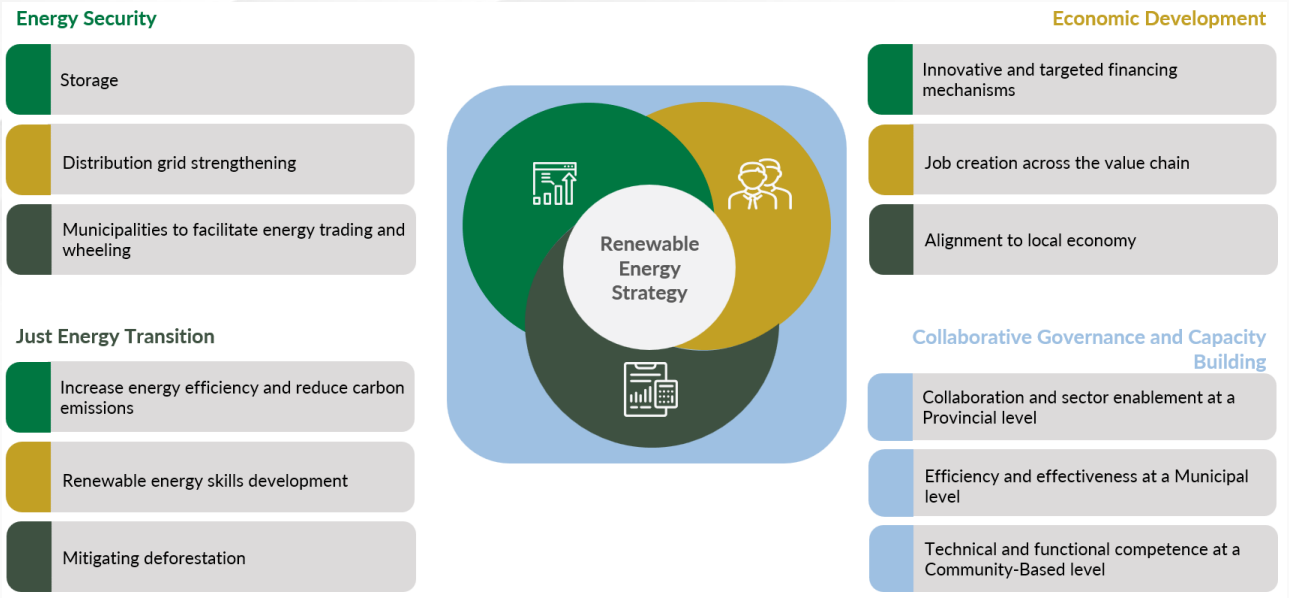
Limpopo could achieve a much larger reduction in reliance on the national grid by 2030 by committing to a base case of 400 MW annual rollout of solar power. This approach has the potential to surpass the initial target of a 10% reduction. By implementing this, the model projects an excess capacity of 900 MW, generating an additional 1 971 GWh of solar energy by 2030. This surplus generation capacity translates to a total projected reduction in reliance on the grid by 19%. If this solar rollout is pursued, supported by a 100MW installation of BESS yearly, the final energy mix in 2030 is likely to include a significant contribution from solar alongside BESS with a projected total capacity of 2 674 GWh from solar and 462 GWh from BESS by 2030.

The reduced reliance on coal generated electricity is expected to deliver significant environmental benefits alongside energy security. A key factor influencing the impact on CO_2 emissions will be the performance of the existing coal fleet. A low performing coal fleet, requiring supplemental gas backup of 5 GW (with an EAF 51%), will lead to a lower grid emission factor compared to a high performing fleet that can operate without additional gas (with an EAF of 65%). With these scenarios, by 2030, Limpopo's grid emission factor would be ~0.495 tCO2/MWh and ~0.603 tCO2/MWh for low and high performing coal fleets, respectively, under the 10% grid reliance reduction scenario. However, if Limpopo achieves the more ambitious target of a 19% reduction by 2030, the grid emission factors could decrease to ~0.105 tCO2/MWh and ~0.127 tCO2/MWh for low and high performing coal fleets, respectively. This highlights the critical role that both renewable energy deployment and coal fleet optimization play in decarbonizing Limpopo's grid.

The success of renewable energy requires unlocking the full potential of solar PV installations across various sectors. Encouraging utility-scale solar farms, promoting rooftop solar adoption in the residential sector and fostering solar solutions in commercial and industrial facilities are all critical aspects.

Strategic Initiatives

The Limpopo Renewable Energy Strategy acts as a central hub, translating its broad strategic goals into concrete actions through a set of key imperatives for each desired outcome as indicated in the figure below. For Energy Security, the focus is on building a robust infrastructure with storage solutions, grid development and empowering municipalities to participate in energy trading. A Just Energy Transition prioritizes reducing carbon emissions through renewable energy sources, while also emphasizing workforce development in this sector and protecting vital forests. Economic development is driven by innovative financing mechanisms, job creation throughout the renewable energy value chain and ensuring alignment with the existing local economy. Finally, collaborative governance and capacity building are fostered through collaboration and sector enablement at a provincial level, efficiency and effectiveness at a municipal level, as well as technical and functional competence at a community-based level to raise awareness and build expertise.

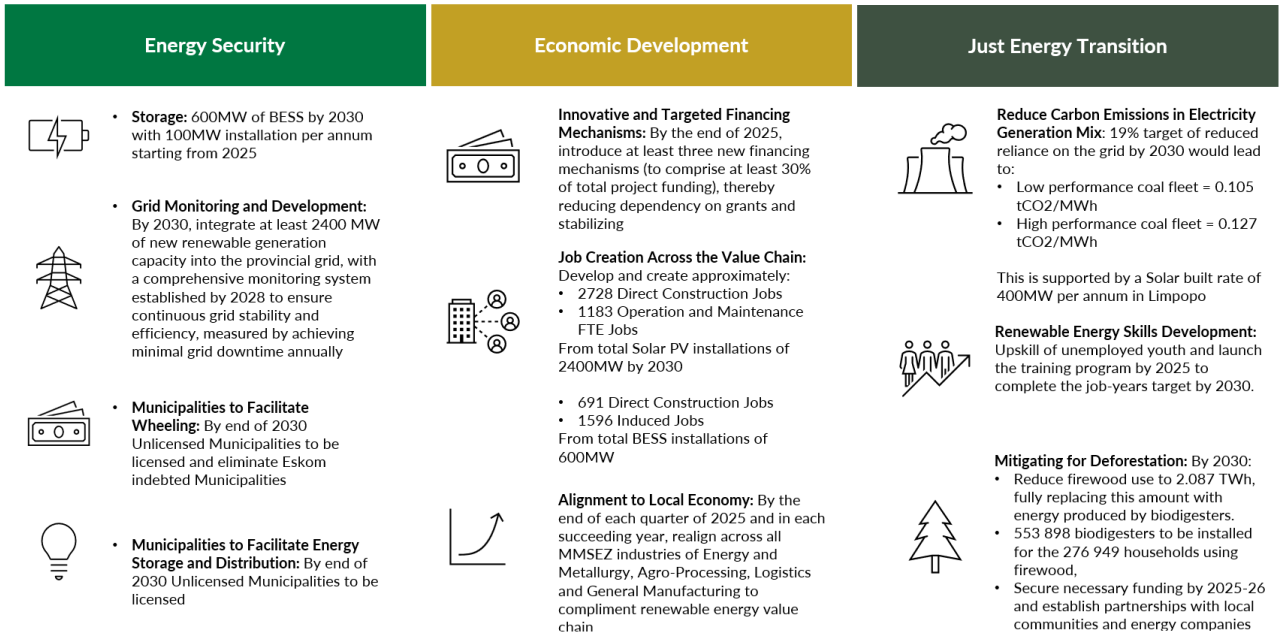


Key imperatives of the strategic outcome

Amongst the key outcomes the most significant expense lies in battery energy storage, with phased installations reaching 600MW by 2030 (100MW installations yearly up to 2030) at an estimated R8.9 billion to R13.7 billion annually. Grid upgrades and a monitoring system for 2 400MW of renewable energy integration come at a cost of R178 million to R445 million with municipal wheeling costs to be determined on a project-by-project basis (indicated in the Figure below).

The economic development program aims to introduce new financing mechanisms for municipalities by the end of 2025. These mechanisms are expected to cover at least 30% of total project funding, reducing reliance on grants and stabilizing funding sources. The program emphasizes leveraging credit solutions, project finance, and other municipal borrowing options within the framework set by the Policy Framework for Municipal Borrowing. This strategy is expected to create new jobs in construction, operation, and maintenance across the renewable energy value chain. The Limpopo Province itself holds potential for mineral resource contributions to the supply chain, with most job opportunities anticipated in renewable energy system installation and operation.

A key focus of the Just Energy Transition Framework is on reducing greenhouse gas emissions and air pollution. The framework outlines a target of achieving a 19% reduction in reliance on the grid by 2030, supported by the development of renewable energy sources. This transition is expected to be facilitated by a solar build rate of 400MW per annum in Limpopo. The framework also emphasizes the importance of addressing the socioeconomic impacts of the transition. By upskilling at least 20% of the unemployed youth in the province and creating new job opportunities in renewable energy sectors, the Just Energy Transition Framework aims to ensure an inclusive and just transition for all.



Key outcomes the strategy aims to achieve

Strategic Interventions

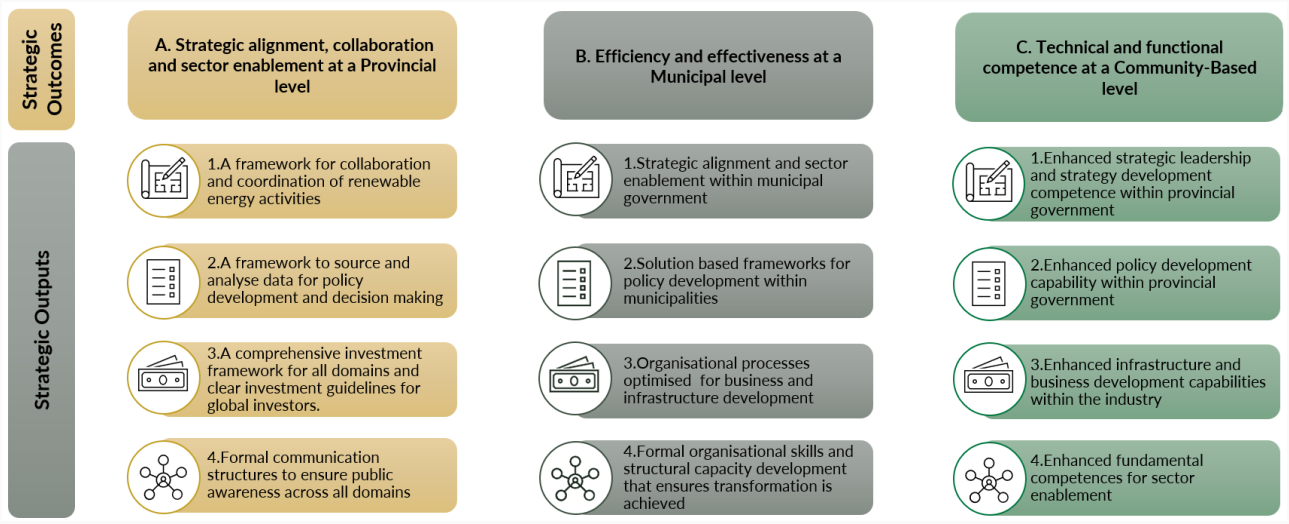
The strategy entails a three-tiered approach to building capacity to improve the strategic, regulatory and technical conditions necessary for establishing a renewable energy strategy in Limpopo.

- **Strategic Outcome 1:** Focuses on the Provincial level, aiming to establish a formal platform for collaboration and coordination, a central platform for data analysis to inform policy decisions and a comprehensive investment framework.

- **Strategic Outcome 2:** Targets the Municipal Level, where the objectives are to leverage technological solutions for policy development, optimize organizational processes for infrastructure development and develop formal communication structures.

- **Strategic Outcome 3:** Addresses the Community-Based Level, aiming to enhance strategic leadership and strategy development, policy development capability, and fundamental competencies for sector enablement. These outcomes are supported by Strategic Objectives that outline specific actions to be taken at each level.

The Limpopo Renewable Energy Strategy and Action Plan provides a roadmap for the province to transition to a clean energy future. The strategy acknowledges the key opportunities and challenges that lie ahead, outlining a clear set of strategies to address them effectively. The successful implementation of this plan canters on collaboration. All stakeholders, including the provincial government, municipalities, the private sector, civil society organizations and local communities, must come together in a unified effort. The figure provides a summary of the capacity development framework with municipal, provincial and community level strategic outcomes. Through this collaborative approach, the Limpopo Renewable Energy Strategy and Action Plan has the potential to transform Limpopo's energy landscape, paving the way for a sustainable and clean energy future.



Capacity development framework with municipal, provincial and community level strategic outcomes

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TABLE OF ABBREVIATIONS

Abbreviation	Description
ABCD	Asset Based Community Development
AC	Alternating Current
BESS	Battery Energy Storage System
BQ	Budget Quotations
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
C&I	Commercial and Industrial
CO_2	Carbon Dioxide
COP26	the 26th meeting of the Conference of the Parties to the UNFCCC
COP27	the 27th meeting of the Conference of the Parties to the UNFCCC
CPI	Consumer Price Impact
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar PV
DBSA	Development Bank of Southern Africa
DDM	District Development Model
DEA	Department of Environmental Affairs
DTIC	Department of Trade Industry and Competition
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EAF	Energy Availability Factor
EIA	Environment Impact Assessment
EP	Equator Principles
EPC	Engineering Procurement and Construction
ESG	Environmental Social Governance
FET	Further Education and Training college
FTSEZ	Fetakgomo Tubatse Special Economic Zone
GCCA	Generation Connection Capacity Assessment
GDP	Growth Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GW	Gigawatt
GWh	Gigawatt hour

IDP	Integrated Development Plan
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	The Intergovernmental Panel on Climate Change
IPPs	Independent Power Producer
IRP	Integrated Resource Plan
JET	Just Energy Transition
JET-IP	Just Energy Transition Investment Plan
KW	Kilowatt
kWh	Kilowatt hour
LCOE	Levelized Cost of Energy
LDP	Limpopo Development Plan
LEDET	Limpopo Economic Development, Environment and Tourism
LNG	Liquefied Natural Gas
merSETA	Manufacturing Engineering and Related Services Sector Education and Training Authority
MFMA	Municipal Finance Management Act
MMSEZ	Musina-Makhado Special Economic Zone
MTSAO	Medium-Term System Adequacy Outlook
MW	Megawatt
MWh	Megawatt hour
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act
NTCSA	National Transmission System Company of South Africa
NZE	Net Zero Emissions
OCGT	Open Cycle Gas Turbines
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
PGMs	Platinum Group Metals
PPA	Power Purchase Agreement
PPP	Public-Private Partnerships
PtG	Power-to-Gas
PTO	Permission to Occupy

PV	Photovoltaics
R/KWh	Rand per Kilowatt hour
RE-IPP	Renewable Independent Power Producer
REIPPP	Renewable Independent Power Producer Programme
RFP	Request For Proposals
RMIPPPP	Risk Mitigation IPP Procurement Programme
SABS	South African Bureau of Standards
SADC	South African Development Community
SAHRA	South African Heritage Resources Agency
SALGA	South African Local Government Association
SANEDI	South African National Energy Development Institute
SAPP	South African Power Pool
SAREM	South African Renewable Energy Masterplan
SDGs	Sustainable Development Goals
SEFA	Sustainable Energy Funds for Africa
SEZ	Special Economic Zone
SMMEs	Small Medium and Micro Enterprises
SSEG	Small-Scale Embedded Generation
STEPS	Stated Policies Scenarios
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TDP	Transmission Development Plan
TVET	Technical and Vocational Education and Training
TW	Terawatt
TWh	Terawatt hour
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNIVEN	University of Venda
USAID	United States Agency for International Development

1 APPROACH

1.1 Overview

This document finalizes the Limpopo Renewable Energy Strategy and Action Plan. The plan underwent a comprehensive development process that began in October 2023. The sixth and final phase, concluding in July 2024, focused on finalizing this key strategy document.

The first phase, Preparation and Activation, involved initiating the project, gathering information through data collection and document review, and setting the stage for stakeholder involvement through the creation of a plan and an initial report. Phase two, As-Is Analysis, investigated the current situation. In this phase a comprehensive analysis of the province's energy landscape, including its policies and regulations were investigated. Phase three, Gap Analysis, assessed the province's energy needs, compared to current resources and identified the gaps. Phase four, Strategy Implementation Planning, involved creating a detailed action plan that outlined the specific steps needed, along with a framework to monitor and evaluate progress. Phase five and six includes the draft and final Strategy Document Development.

This document provides a roadmap for the province to transition to a clean energy future. This roadmap acknowledges the key opportunities and challenges that lie ahead, outlining a clear set of strategies to address them effectively. However, the successful implementation of this plan centres on collaboration. All stakeholders, including the provincial government, municipalities, the private sector, civil society organizations and local communities, must come together in a unified effort. Through this collaborative approach, the Limpopo Renewable Energy Strategy and Action Plan has the potential to transform Limpopo's energy landscape, paving the way for a sustainable and clean energy future.

1.2 Approach

Several steps were followed throughout the project to arrive at the final strategy report.

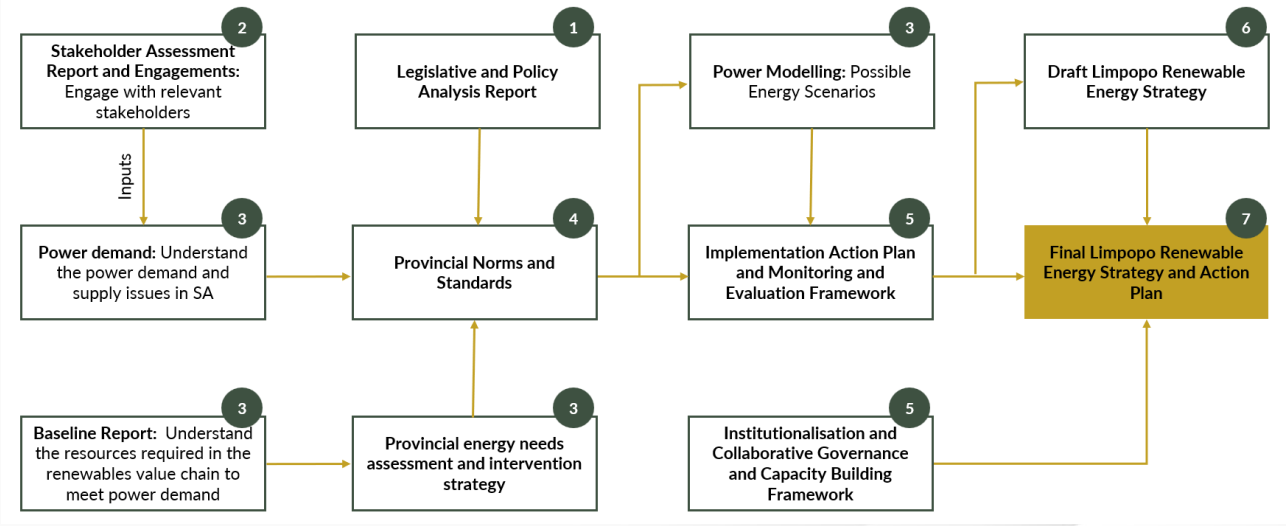


Figure 1: Overall project structure

A high-level approach to inform the creation of the strategy is depicted in Figure 2. The diagram outlines the key analytical requirements for forecasting and model development in crafting the provincial renewable energy strategy. It highlights three main analysis areas: supply, demand, and regulatory environments. Each area has sub-categories for in-depth consideration.

Supply analysis investigates the regional, national, and local renewable energy markets, assessing their strategic position against traditional options. It evaluates the supply chain, value chain, security of supply, and potential scenarios. Demand analysis examines the overall energy demand through economic proxy analysis and district-level profiling for potential renewable energy adoption. It considers economic development as a driver and explores integration options across various sectors, including domestic, residential, commercial, industrial, and agricultural consumers. The regulatory analysis focuses on the policy, legal, regulatory, and fiscal frameworks impacting renewable energy development. It examines market structures, investment requirements, just energy transition considerations, and broad socio-economic benefits. This analysis also considers route-to-market options and infrastructure development.

Forecasting and model development leverage the insights from these analyses. This stage involves building models that can predict future energy demand and supply based on various scenarios. These models consider factors like economic growth, technological advancements, climate change mitigation goals, and policy changes. The resulting outputs can assist in attaining goals such as energy security, just energy transition and economic development.

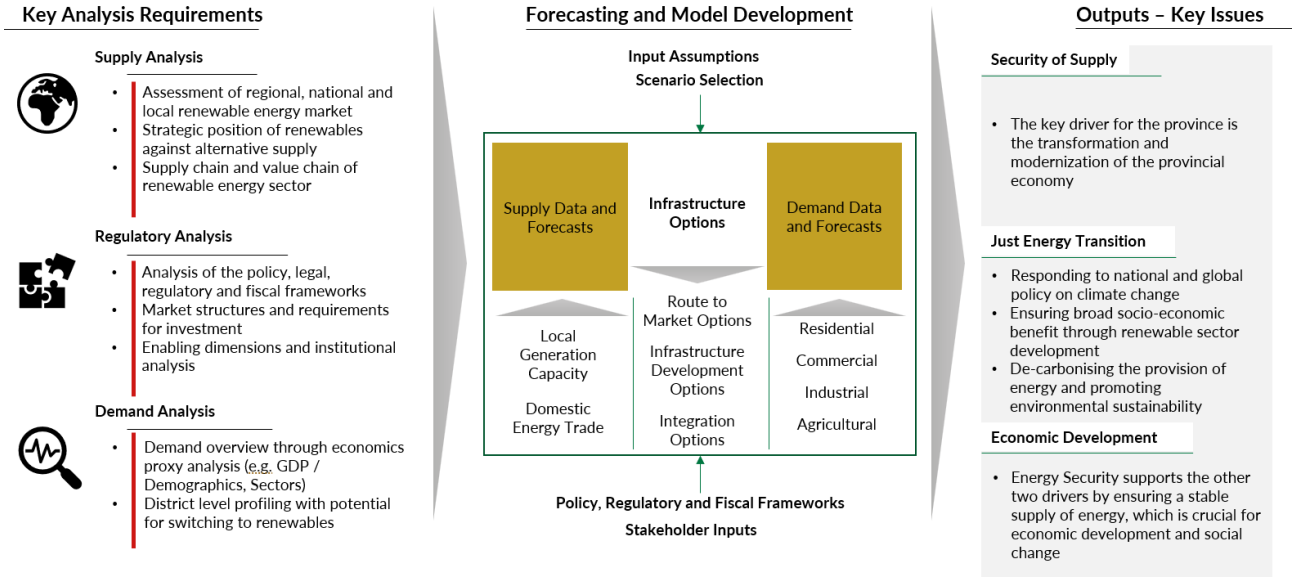


Figure 2: High-level approach to inform the creation of the strategy

Figure 3 depicts the key considerations for bridging the gap between energy supply and demand. It highlights the need to address several areas: Eskom supply, municipal demand, renewable energy sources, and internal and external enablers. By addressing these considerations, the renewable energy strategy can bridge the gap between Eskom supply and municipal demand through a sustainable approach that leverages renewable energy sources. This will contribute to the province's energy security and environmental goals.

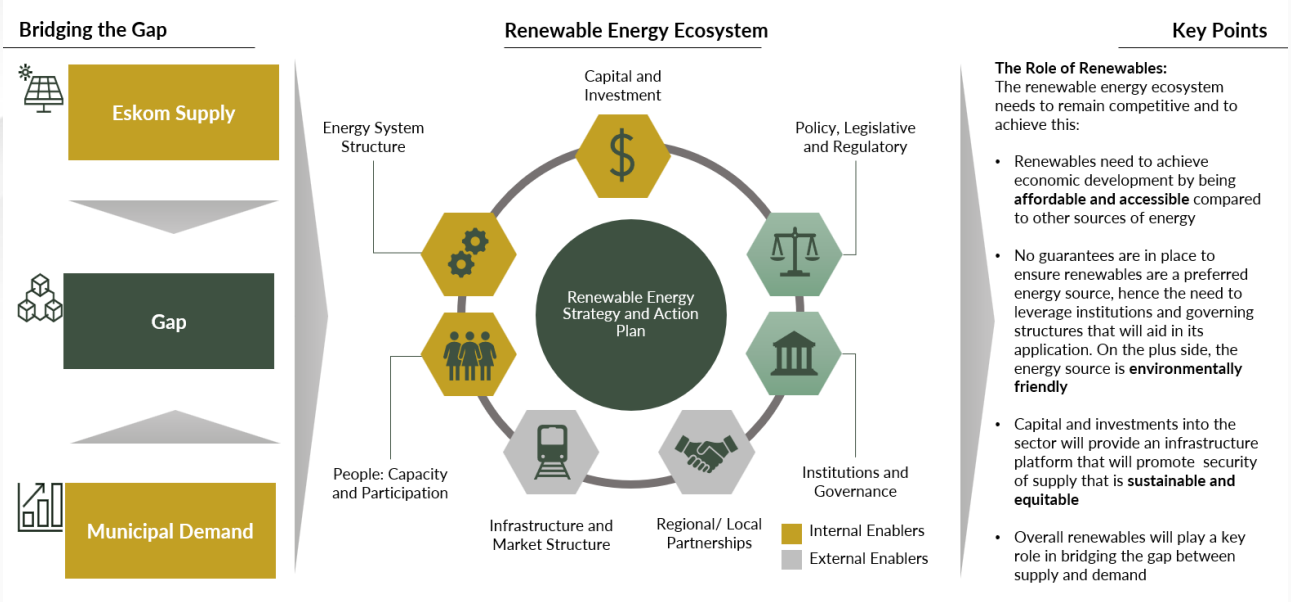


Figure 3: The role of renewables to bridge the electricity deficit

2 LEGISLATION AND POLICY ANALYSIS

2.1 Legislation, Policies, Plans and Programmes

This section presents an analysis of the policy framework and its influence on renewable energy in South Africa and Limpopo (Figure 4). Each policy objective is identified and the core aspirations it strives to achieve for renewable energy in the country. The mechanisms of each policy are explored, identifying the tools and processes it employs to achieve its objectives. This encompasses aspects like financial incentives, regulatory frameworks, spatial planning measures, and institutional arrangements. This includes the impacts of each policy, evaluating its effectiveness in achieving its stated goals like renewable energy deployment rates, job creation figures, greenhouse gas emission reductions, and any unintended consequences.

Furthermore, implications for Limpopo are noted given each policy's unique contributions and shortcomings which are evaluated. This analysis highlights opportunities for alignment and identifies potential challenges.

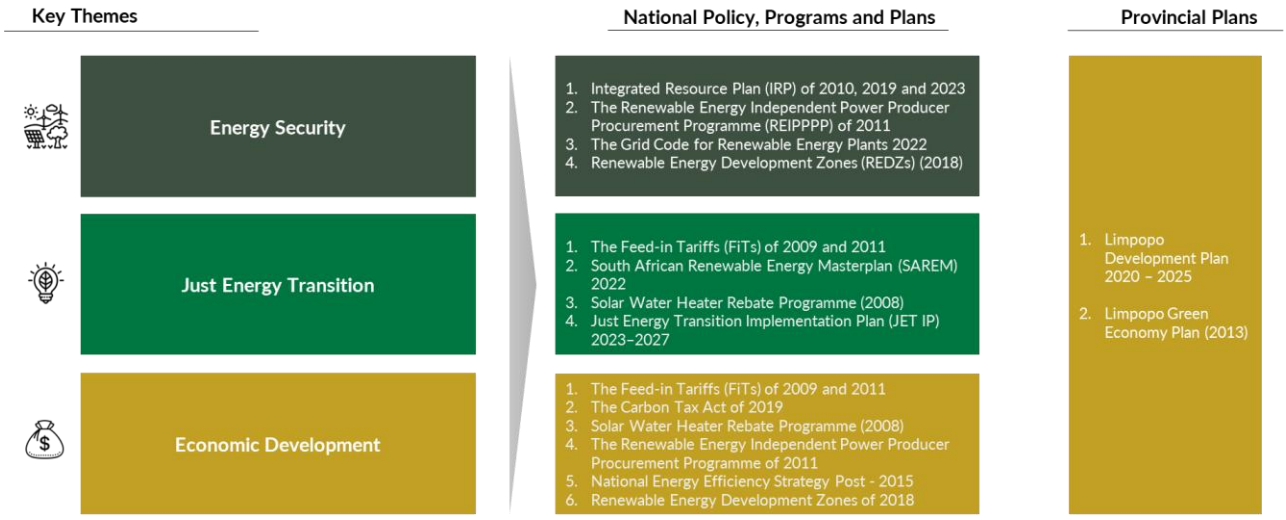


Figure 4: Key themes with national and provincial policies, programs and plans

While some of the policies, plans, and programs mentioned may no longer be actively implemented, they played a significant role in laying the groundwork for South Africa's renewable energy journey. For instance, the White Paper on Renewable Energy (2003)[1] established the country's initial renewable energy vision and targets, paving the way for subsequent developments. Similarly, the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)[2], launched in 2010 and ongoing, has been instrumental in attracting private investment and accelerating project development Notably, many of these initiatives had distinct start and end dates, as shown in Figure 5. This highlights the dynamic nature of policy and program development, where some interventions pave the way for future progress while others served their purpose and concluded.

[1] Department of Energy. (2003). White Paper on Renewable Energy

[2] Department of Energy. (2011). Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

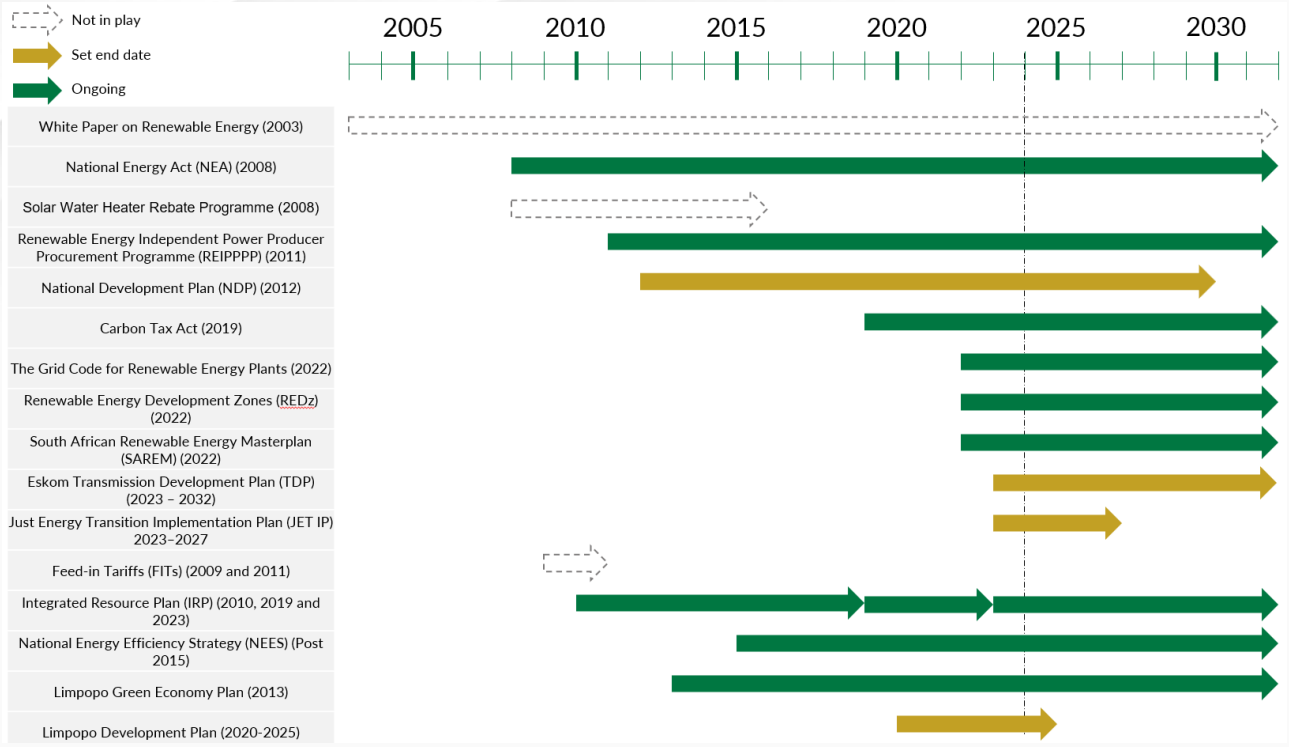


Figure 5: Timeline of National and provincial acts, policies, plans and programs

In South Africa, the Constitution outlines distinct roles for provinces and municipalities regarding electricity. Schedule 4B of the document explicitly designates electricity and gas reticulation as a local government responsibility. This empowers municipalities to act as electricity service authorities, owning and maintaining the infrastructure within their jurisdictions for distributing electricity to residents and businesses. They are tasked with ensuring reliable and cost-effective distribution in accordance with national minimum standards set by the National Energy Regulator of South Africa (NERSA). In some instances, the power utility, Eskom, is responsible for this.

Provinces, on the other hand, do not have direct authority over electricity distribution. However, they play a role in planning and coordinating local government interventions through provincial and regional development plans.

It's crucial to recognize that municipalities operate within a broader framework established by the national government. While the Constitution grants them autonomy in service delivery, the National Electricity Act and related legislation set broader parameters and regulatory oversight to ensure efficient and equitable access to electricity throughout the country. This multi-layered system aims to balance local needs with national energy goals.

2.2 Key National Policies

South Africa's renewable energy landscape wouldn't be what it is today without the foundational groundwork laid by three key policies (at a national level):

2.2.1 White Paper on Renewable Energy of 2003[3]

This document outlines the ambitious targets for renewable energy penetration. It envisioned a South Africa powered by diverse sources, achieving energy security and environmental sustainability. Notably, the White Paper set a target of 10% contribution from renewable energy to the national electricity grid by 2013. In addition, the White Paper paved the way for concrete action, laying the foundation for market mechanisms like feed-in tariffs and kickstarting policy development in this field.

2.2.2 National Energy Act of 2008[4]

The National Energy Act of 2008 provided the legal framework for implementing the White Paper's goals. It gave the National Department of Energy the mandate to promote renewable energy and established mechanisms for achieving the targets. The Act established the Integrated Energy Plan (IEP) as the roadmap for guiding energy investments, set specific requirements for renewable energy integration into the grid, and provided fiscal and regulatory incentives. It transformed the White Paper's broad ideas into actionable guidelines and empowered the government to drive renewable energy development.

2.2.3 National Development Plan of 2012 (NDP)[5]

The NDP articulated the broader societal benefits of renewable energy. The NDP recognized the potential to unlock economic growth, create jobs, and alleviate poverty, thereby promoting social equity and a just transition. By setting ambitious targets for renewable energy capacity (20 GW by 2030) and outlining key strategies like spatial planning and infrastructure development, the NDP provided a roadmap for realizing this vision.

2.2.4 State of the Nation Address (SONA)[6]

In addition, the government's stance on renewable energy, as reflected in the State of the Nation Address (SONA), has evolved over time. The latest address, delivered in February 2023, places a strong emphasis on renewables as a solution to the country's pressing electricity crisis and a key driver of future economic growth. This is evident in the plans to accelerate the procurement of 11,800 MW of new energy, indicating that there are now more than 100 projects, which are expected to provide over 9 000 MW of new capacity over time including a number of companies that have participated in the renewable energy programme which aim to deliver a total of 2800 MW of new capacity with a significant focus on wind, solar, and battery storage. Additionally, the Just Energy Transition Investment Plan (JET-IP)[7] allocates R1.5 trillion towards renewable energy development over the next five years, showcasing the government's long-term commitment to the sector.

2.3 Key Provincial Policies

2.3.1 Limpopo Development Plan (2020-2025)

From a provincial point of view The Limpopo Development Plan (2020-2025)[8], highlighted the crucial role of renewable energy in the province's future. Recognizing the threats of climate change, rising fuel costs, and energy security concerns, the plan emphasized the potential of solar energy given Limpopo's abundant land and favourable solar radiation. It indicates that renewables could create both direct and indirect jobs, showcasing the significant economic and environmental benefits. Overall, the plan prioritizes renewable energy development as a vital strategy for Limpopo's sustainable growth.

[3] Department of Energy. (2003). White Paper on Renewable Energy
[4] Department of Energy. (2008). National Energy Act (Act No. 34 of 2008)
[5] National Planning Commission. (2012). National Development Plan 2030: Our Path to Prosperity
[6] The Presidency. (2023). State of the Nation Address
[7] The Presidency. (2023). Just Energy Transition Implementation Plan (JET IP) 2023–2027
[8] Limpopo Provincial Government. (2020). Limpopo Development Plan 2020-2025

2.3.2 Limpopo Green Economy Plan

The Limpopo Green Economy Plan outlines a strategic vision for the province to emerge as a national frontrunner in the green economy. This plan emphasizes environmentally responsible and socially just economic activities across various sectors including green agriculture, construction, manufacturing, infrastructure development, and science and technology services. The plan acknowledges the potential for the green economy to create jobs, tackle social issues like poverty and unemployment, and ensure environmental protection. Successful implementation hinges on collaboration between government departments, the private sector, and local communities.

2.3.3 Eskom Transmission Development Plan (TDP) 2023-2032

Eskom Transmission Development Plan (TDP)[9] 2023-2032 highlights some of the current renewable energy project deployed in the province. Currently:

a) The Witkop Solar PV contributes 30 MW.
b) The Soutpan solar PV is 28 MW.
c) The Villa Nora solar PV a total of 60 MW.

In addition, the TDP highlights the future potential of renewable energy for the province, indicating that 1918 MW of solar PV generation by 2032.

2.3.4 State of the Province Address (SOPA)

The State of the Province Address[10] delivered in February 2023 by the Premier of the Limpopo Province recognized the responsibility of the province in the energy transition to overcome the energy crisis and build a just future and ensuring a stable power supply for essential services. The Office of the Premier indicated it will lead and coordinate provincial efforts, focusing on two key initiatives:

a) Developing a comprehensive provincial energy plan to generate new electricity within Limpopo.
b) Integrating energy production projects into both government and municipal plans. This includes exploring the retrofitting of solar panels on all government buildings, implemented strategically to complement Eskom's endeavours.

Together, these actions demonstrate Limpopo's commitment to playing a proactive role in building a sustainable and equitable energy future. The Priemer highlighted several initiatives including the Renewable Energy Strategy by Musina-Makhado Special Economic Zone (SEZ) in partnership with the United States Agency for International Development and the Nalane Green Solar Energy Project, which has started implementing their R5 billion investment pledge, providing a unique, socially responsible, approach to energy generation.

2.4 Key Shifts in Policies

The South African government has ratified policy changes to expedite renewable energy development, particularly through revisions to its electricity regulatory framework such as the Electricity Regulation Act (2006) and the establishment of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in 2011.

[9] Eskom. (2023). Eskom Transmission Development Plan (TDP) 2023 – 2032
[10] The Presidency. (2023). State of the Nation Address

2.4.1 The ability of municipalities to purchase electricity from Independent Power Producers

In October 2020, the Minister of Mineral Resources and Energy, gazetted amendments to the Electricity Regulations on New Generation Capacity (2011)[11] in terms of the Electricity Regulation Act of 2006 providing scope for municipalities to develop their own power generation projects, subject to certain requirements. Notably, municipalities must complete a feasibility study if delivering the project internally, adhere to financial regulations for external mechanisms, and demonstrate alignment with their development plans.

A significant change was made to the Electricity Regulation Act of 2006, impacting how electricity is purchased and distributed in South Africa. Previously, Section 8(f) granted Eskom, the state-owned utility, the "exclusive right to purchase electricity for bulk resale within South Africa." This monopoly limited competition and prevented provinces and large consumers from directly buying electricity from independent power producers (IPPs).

However, amendments were made to the act in 2020 which clarified that municipalities meeting specific criteria, such as financial good standing and technical capacity, can now purchase electricity directly from independent power producers (IPPs). This opens doors to explore renewable energy options and potentially achieve greater energy independence, reducing reliance on Eskom's centralized grid. Additionally, to ensure optimal pricing and efficient project selection, the regulations mandate competitive bidding processes for IPP projects. This fosters a spirit of transparency and fairness, attracting diverse and cost-effective solutions for municipalities.

2.4.2 Removal of license limit

The most significant change, under the Electricity Regulation Act (2006), was removing the licensing requirement. Previously, Section 3 of Schedule 2 of the Act established a licensing requirement for generation facilities with a capacity exceeding 1 MW. This meant any project between 1 MW and 100 MW needed a license from NERSA however, obtaining a license was a complex and time-consuming process, hindering the development of renewable energy projects. In June 2021, amendments were made to Schedule 2, removing the 100MW limit. Further amendments were made in December 2022 which provided an exemption to those operating generation facilities, with or without battery storage, under specific conditions. These include facilities used solely for backup during power outages, those not connected to the grid, and smaller facilities (up to 100 kW) complying with technical regulations and grid connection rules. These changes dramatically simplified and expedited the approval process, boosting private investment in smaller-scale renewable projects. Other amendments within the act have streamlined processes, clarified regulations, and improved transparency for renewable energy projects.

2.4.3 Launch of the REIPPPP (2011)

The IRP in South Africa has implemented multifaceted strategies to encourage the development of community-based renewable energy installations and support independent power producers, ultimately improving access to electricity in rural areas. Recognizing the unique challenges and opportunities within these segments, the IRP has deployed several key tactics including specific quotas within bidding rounds that are allocated for smaller-scale (<10 MW) projects and community-based developments, ensuring dedicated access and fair competition. The plan acknowledging potential limitations in some communities and offered flexible technical and administrative requirements for smaller projects, facilitating their participation.

To meet the ambitious targets set out in the Integrated Resource Plan of 2010[12] and the National Development Plan (2012)[13], the REIPPPP[14] was launched in 2011. Through competitive bidding rounds, it attracted

[11] Department of Mineral Resources and Energy. (2011). Electricity Regulations on New Generation Capacity
[12] Department of Mineral Resources and Energy. (2010, 2019, 2023). Integrated Resource Plan for Electricity in South Africa
[13] National Planning Commission. (2012). National Development Plan 2030: Our Path to Prosperity
[14] Department of Energy. (2011). Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

investment, diversified the energy mix with wind, solar, and other technologies, and dramatically reduced costs. Prices of awarded projects plummeted from R2.73/kWh to under R0.70/kWh, making renewable energy a viable competitor to fossil fuels. Streamlined processes and transparency boosted trust, while community development mandates created jobs and infrastructure in disadvantaged areas. Beyond procurement, the REIPPPP nurtured a thriving renewable energy industry, attracting diverse investors.

2.5 Detailed Policy Analysis

This section provides a detailed analysis of policies, plans, and programs, both past and present, that have shaped the renewable energy landscape. It details their objectives, the mechanisms employed, and the resulting outcomes, to gain insights into the effectiveness and impact. These have been categorized according to three critical themes: energy security, just energy transition, and economic development.

2.5.1 Energy Security

The Renewable Energy Independent Power Producer Procurement Programme of 2011

The REIPPPP was launched in 2011 and set clear and measurable objectives aiming to transform the nation's energy landscape. The objectives of the programme include and are not limited to securing additional electricity generation capacity from renewable energy sources through private investment and facilitate the development of renewable energy projects, such as wind, solar photovoltaic (PV), concentrated solar power (CSP), biomass, and small-scale hydroelectric power.

Recognizing the risks associated with a single-fuel source, the REIPPPP aimed to significantly diversify the energy mix. Its ambitious target of adding 17,800 MW of renewable energy by 2030 served to reduce reliance on volatile coal prices and geopolitical disruptions in fuel supply, thereby increasing security and resilience.

Another crucial objective of the program was to address immediate generation shortfalls and ensure long-term grid stability by fostering the development of clean energy sources, aiming to inject substantial megawatts into the grid, to ensure a reliable electricity supply for sustainable economic growth.

The program prioritized fostering domestic renewable energy development, thereby promoting self-reliance and reducing dependence on imported fossil fuels and unlike fluctuations associated with fossil fuels, renewable energy sources offer cost certainty and predictability. The REIPPPP's focus on renewables contributed to enhanced energy security by stabilizing fuel prices and bolstering overall economic stability.

With regards to Limpopo's renewable energy strategy, IPPs in the province can benefit via the bid windows offered by the REIPPPP. Currently, Bid Window 7 calls for 1800 MW of Solar PV and 3200 MW of Wind Power with Bid Window 8 aiming to procure an additional 5000 MW (not released yet). However, there are concerns regarding grid access and capacity. The TDP[15] highlights plan to increase capacity of existing substations in Limpopo (Leseding, Boruth, Warmbad and Acornhoek).

The Renewable Energy Development Zones of 2018

The REDZs[16] of 2018 are designated geographical areas in South Africa established to streamline, expedite, and optimize large-scale renewable energy development. They refer to areas where wind and solar PV development can occur in concentrated zones, which will essentially lead to the reduction of negative

[15] Eskom. (2023). Eskom Transmission Development Plan (TDP) 2023 – 2032
[16] Department of Forestry, Fisheries and the Environment. (2022). Renewable Energy Development Zones (REDz) Guideline Document

environmental consequences, assist in the alignment of authorization and approval processes and attractive incentives. Initially eight strategic zones (Overberg, Komsberg, Cookhouse, Stormberg, Kimberley, Vryburg, Upington and Sprinkbok) were identified for the development of large-scale wind and solar photovoltaic facilities. Following this, an additional three zone were identified (Emalahleni, Klerksdorp and Beaufort West). These zones have been chosen based on their potential in terms of wind and solar energy, as well as their proximity to coal-fired power plants to be decommissioned.

The Renewable Energy Development Zones are also aligned with the powerline corridors that were identified in the Electricity Grid Infrastructure Strategic Environmental Assessment (SEA) completed in 2016 and gazetted as powerline corridors in 2018.

Although the REDZs were identified across the country, no REDZs were identified within the Limpopo province.

Integrated Resource Plan (IRP) of 2010, 2019 and 2023

The energy minister has published a revised IRP[17] in the Government Gazette for public comment. The plan is a crucial energy policy document that elaborates on the electricity demand, whilst simultaneously aiming to give possible electricity supply technologies that will meet the electricity demand over the medium term. In essence the draft IRP 2023 document emphasizes the issue of energy security and environmental sustainability. The IRP 2023 considers two-time horizons. Horizon One is for 2023–2030 and focuses on stabilizing South Africa's electricity supply to end rotational power cuts and Horizon Two which is for 2031–2050 to ensure South Africa has sufficient generating capacity to meet demand for the coming decades.

Regarding Horizon One the goal of the IRP is to enhance capacity of new generation capacity by 2030, comprising of 6000 MW of gas — 3000 MW from Eskom and 3000 MW from independent producers, 1500 MW of photovoltaic solar, 3000 MW of wind and 2000 MW of battery storage.

For Horizon Two, the IRP considers five different pathways. These are a reference case, transitioning the power system to renewables (including and excluding nuclear), delaying the shutdown of coal power stations, and deploying cleaner coal technologies with renewables. The reference case is the cheapest path with a total system cost of R5.9 trillion and allows South Africa to choose technology combinations without restrictions, Transitioning the power system to renewables builds the most new generation capacity by 2050 and is the most expensive option at R8.4 trillion, delaying the shutdown of Eskom's existing coal power stations proposes extending the lives of specific plants by ten years and the fifth pathway allows for up to 6,000MW of cleaner coal technologies to be deployed and has a cost of R6.1 trillion.

Limpopo province can leverage of the Integrated Resource Plan (IRP) 2023 Horizon One analysis which plans to have new additional capacity. In addition, the commercial and residential sector in Limpopo can contribute to the solar rooftop roll-out beyond installation of panels on government buildings. However, to meet the IRPs targets for renewables, South Africa would need to construct about 14 000km of transmission lines in 10 years requiring the province to assess the transmission and distribution technologies.

The Grid Code for Renewable Energy Power Plants (RPPs) 2022

The Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission System or the Distribution System of 2022[18] directly contribute to energy security by ensuring that the

[17] Department of Mineral Resources and Energy. (2010, 2019, 2023). Integrated Resource Plan for Electricity in South Africa
[18] National Energy Regulator of South Africa. (2022). The Grid Code for Renewable Energy Plants

integration of new power generation facilities, especially ones relating to Renewable Power Plants does not compromise the stability and reliability of the national grid.

By ensuring that there are clear technical and operational standards, the Grid Code aids in maintaining a stable supply of electricity, which is fundamental aspect of energy security. In essence the Grid Code plays a vital role in improving energy security by ensuring grid stability, facilitating the integration of renewable energy, supporting efficient and forward-looking system planning, and creating a conducive environment for investment and innovation in the energy.

The province will rely on the Grid Connection Code for Renewable Power Plants Connected To The Electricity Transmission System or The Distribution System of 2022 to integrate renewable energy sources into the grid. It is noted that renewable energy, especially wind and solar, introduces unique complexities into power systems, particularly in frequency and voltage regulation therefore compliance with these standards is essential to allow for the seamless connection of renewable energy projects.

Limpopo Development Plan 2020 – 2025

The Limpopo Development Plan 2020 - 2025[19] highlights that energy security is a major component in the implementation of the plan.

The plan highlighted three strategic drivers regarding energy security. The first driver is to protect existing electricity generation and distribution infrastructure, the second driver is to reduce demand and the third driver is to broaden the energy mix and to introduce alternatives to augment the energy supply.

The province indicated that in 2016, 5.6% of households reported that they do not have access to electricity with two districts below the provincial average, namely Waterberg (12.3%) and Sekhukhune (8.1%). The main supply of electricity in Limpopo is through the Eskom prepaid system (81.4% of households), followed by the municipality prepaid system that supplies 13.6% of households.

Limpopo Green Economy Plan (2013)

The Limpopo Green Economy Plan (2013)[20] advocates for community engagement and ownership in green economy projects to ensure equitable distribution of benefits and mitigate negative impacts on communities reliant on traditional energy sources. The plan recognizes the vulnerability of Limpopo's energy supply due to its dependence on coal-fired power generation and increasing national grid constraints. It promotes diversification of the energy mix by advocating for increased renewable energy deployment, particularly solar.

The plan had laid the groundwork for diversifying energy sources and promoting renewable energy, potentially enhancing energy security and resilience in the long term but requiring significant investment and infrastructure upgrades.

[19] Limpopo Provincial Government. (2020). Limpopo Development Plan 2020-2025
[20] Limpopo Provincial Government. (2013). Limpopo Green Economy Plan

2.5.2 Just Energy Transition

Solar Water Heater Rebate Programme (2008)

The Solar Water Heater Rebate Programme (2008)[21] programme contributed indirectly to the Just Energy Transition by promoting the adoption of solar water heaters, allowing the solar water industry to grow significantly over a four-year period. The programme came to an end in 2016 after 7 years as only 102,498 high pressure solar water heater systems, 11% of the original target, had been installed. The project sparked initial awareness and adoption of renewable technology for low-income households, but its limited reach and short lifespan hindered its broader impact on a just energy transition. Ultimately the programme managed to stimulate the supply, but not the demand-side of the market.

There is potential to create a similar programme for middle to low-income households in Limpopo. There has been suggestions to adapt the rebate scheme for residential battery storage systems which could help ease some of the load-shedding, assist with economic development and/or job creation.

The Feed-in Tariffs (FiTs) of 2009 and 2011

At the end of 2007, the National Energy Regulator of South Africa commissioned the development of a Renewable Energy Feed-in Tariff (REFIT)[22] for South Africa. The feed-in tariff requires the Renewable Energy Purchasing Agency (REPA), in this case the Single Buyer Office of the national electricity utility Eskom, to purchase renewable energy from qualifying generators at pre-determined prices. These predetermined prices acted as an incentive to renewable energy developers and private investors by reducing financial risk and providing market certainty. The REFIT aimed at supporting the government's target of 10,000 GWh renewable energy by 2013 and promoting competitiveness for renewable energy with conventional energies in the medium and long-term.

Phase 1 of the REFIT was launched in March 2009, with four priority technologies, namely, landfill gas, small hydro, wind and concentrating solar power. These were selected based on the 2004 Department of Minerals and Energy (DME) financial and economic study which focused on the optimal mix of technologies required to fulfil the country's renewable energy targets.

Phase 2 was published in October 2009, following public consultation, and included the following additional technologies; biomass solid waste, biogas through anaerobic digestion; building integrated and ground-mounted large-scale solar PV systems with a capacity greater than 1 MW; CSP with a capacity greater than 10 MW, mounted on a two-axis tracker on the ground; and CSP without storage and central tower technology with six hours of storage a day.

However, in 2011 the Department of Energy revised its renewable energy strategy, switching from the REFIT remuneration system to a procurement process based on price competition. Although the REFIT programs of 2009 and 2011 are no longer active they have been superseded by the REIPPPP, which currently serves as the primary mechanism for procuring renewable energy in the country which Limpopo can benefit from.

[21] Department of Energy. (2008). Solar Water Heater Rebate Programme Guidelines
[22] National Treasury. (2009, 2011). Feed-in Tariffs for Renewable Energy

South African Renewable Energy Masterplan (SAREM) (2022)

The South African Renewable Energy Masterplan (SAREM) (2022)[23] plays a crucial role in facilitating a just energy transition for the country. It recognizes the significant economic and social challenges associated with moving away from fossil fuels and actively seeks to mitigate them. According to the draft Masterplan, South Africa intends to be part of the growth in solar PV and wind energy technologies that in 2021 globally reached, on average, $0.048 (R0.86) and $0.033 per kilowatt-hour (kW/h), respectively. In South Africa, they similarly reached R0.375 per kW/h for solar PV and R0.344 per kW/h for wind energy technologies in 2021.

The analysis underpinning SAREM indicates that localizing 70% of the components and 90% of Balance of Plant and Operations and Maintenance in the wind and solar PV value chains, combined with battery energy storage, could deliver 36 500 new direct jobs by 2030, with a total Gross Domestic Product contribution of R420 billion. These imperatives can be supported by bringing emerging suppliers into the value chain, with a particular emphasis on active participation in ownership and management. By 2030, 10% of renewable energy manufacturing can be in areas that are set to see a reduction in coal activity – known as Just Transition hotspots where around 10 000 youth and former coal employees can be trained to pivot existing skills towards new job opportunities.

Limpopo can leverage of this transition promoting local manufacturing, job creation in affected communities, and ownership opportunities in the renewable energy, while also transitioning away from coal.

Just Energy Transition Implementation Plan (JET IP) 2023–2027

South Africa's JET IP 2023–2027[24] sets out the scale of need and the early-stage investments required for the country's Just Transition to a low-carbon and climate-resilient economy in line with its updated Nationally Determined Contribution (NDC) lodged with the United Nations Framework Convention on Climate Change in 2021.

To decarbonize South Africa's economy within the NDC target range of 350–420 Mt CO2eq by 2030, it will require approximately R 1.5 trillion over five years from multiple sources. The investments are needed in three priority sectors: electricity, New Energy Vehicles and Green Hydrogen and in two cross-cutting areas: skills development and municipalities.

Limpopo can leverage grants, concessional loans, and commercial financing facilities that have been pledged to South Africa through the JET IP. At COP26 in 2021, five international partners pledged USD 8.5 billion (about ZAR 148.75 billion) and during 2023, international pledges to the JET IP grew to USD 11.6 billion (about ZAR 198.2 billion). However, Eskom's TDP estimates a financing shortfall for transmission infrastructure of about R 250 billion. The JET IP targets this investment to be made by the private sector, largely through the REIPPPP where South Africa is confronted with the daunting task of constructing approximately 1500 km of new transmission lines annually over the next decade.

Limpopo Development Plan 2020 – 2025

Central to meeting the vision enshrined in the NDP, the Limpopo Development Plan states that by 2030 it seeks to transition to an environmentally sustainable, climate change-resilient, low-carbon economy and just

[23] Department of Mineral Resources and Energy. (2022). South African Renewable Energy Masterplan (SAREM)
[24] The Presidency. (2023). Just Energy Transition Implementation Plan (JET IP) 2023–2027

society. The essence of the plan is to improve standards of living and to reduce poverty, unemployment and unacceptable levels of inequality. The plan highlighted the need to diversify the provincial economy considering mine closures taking place. One of the opportunities to address this is to increase the Green Economy looking at alternative energy production.

Limpopo Development Plan 2020-2025[25] seeks a just energy transition by promoting renewable energy access, skills development, and community ownership, but faces challenges in ensuring equitable distribution of benefits and supporting affected communities.

Limpopo Provincial Climate Change Response Strategy 2016 – 2020

The Limpopo Provincial Climate Change Response Strategy (2016-2020) serves as a roadmap for the province to address climate change challenges. Building upon existing development plans, the strategy fosters a collaborative effort amongst various stakeholders. Key objectives include establishing a unified provincial vision on climate response, leveraging existing strengths, and proactively tackling climate issues. It identifies areas requiring further knowledge and establishes a framework for collaboration across sectors and organizations. The strategy emphasizes long-term, integrated planning to effectively manage climate change within Limpopo. It acknowledges the inevitability of certain changes and outlines adaptation measures. Additionally, it prioritizes mitigation efforts in key areas like energy, transportation, and resource efficiency.

Limpopo Green Economy Plan (2013)

The plan highlighted that the medium to long term goal will be to address skills shortages in the sector. The plan advocates for community engagement and ownership in green economy projects to ensure equitable distribution of benefits and mitigate negative impacts on communities reliant on traditional energy sources. Although the Limpopo's Green Economy Plan advocated for renewable energy it lacked concrete measures for equity and community engagement.

2.5.3. Economic Development

Solar Water Heater Rebate Programme (2008)

From an economic development point of view the Solar Water Heater Rebate Programme (2008)[26] programme offered financial incentives in the form of rebates to consumers who invested in and installed eligible renewable energy systems. Solar water heater purchasers receive a direct rebate, after submitting a claim for the rebate to Eskom's auditors. According to Eskom the initial budget when the project was announced in 2008 was to a value of R 2.5 billion. The programme aided homeowners by reducing the electricity bill as water heating accounts for about 40% of most homes' electricity bill. The program also had positive effects on employment creation with the solar water heating market expanding from a mere 20 suppliers in 1997 to more than 400 suppliers in 2011.

Similar programs as such can be developed for Limpopo which focus on the smaller players such as homeowners and local markets.

[25] Limpopo Provincial Government. (2020). Limpopo Development Plan 2020-2025

[26] Department of Energy. (2008). Solar Water Heater Rebate Programme Guidelines.

The Feed-in Tariffs (FiTs) of 2009 and 2011

Phase 1 of the REFIT[27], launched in March 2009, consisted of four priority technologies, namely, landfill gas, small hydro, wind and concentrating solar power (CSP). For 2009 the FITs were R1.25/kWh for wind, R0.94/kWh for small hydro (less than 10 MW), R0.90/kWh for landfill gas and R2.10/kWh for concentrating solar power (CSP). Phase 2 was published in October 2009, following public consultation, and included the following additional technologies; biomass solid waste, biogas through anaerobic digestion; building integrated and ground-mounted large-scale solar PV systems with a capacity greater than 1 MW; CSP with a capacity greater than 10 MW, mounted on a two-axis tracker on the ground; and CSP without storage and central tower technology with six hours of storage a day. Phase II tariffs were R3.14/kWh for CSP trough without storage, R2.31/kWh CSP Tower with storage of 6 hours per day, R3.94/kWh for large-scale (1MW or more) grid connected PV systems, R1.18/kW for solid biomass and R0.96/kWh for biogas.

The Renewable Energy Independent Power Producer Procurement Programme of 2011

Since the launch of this public-private partnership, US $16 billion in private investment has been committed for 79 awarded projects totalling 5,243 MW of renewable energy. The program has resulted in significant reductions in tariff rates for solar photovoltaics and wind over a short period. In particular, the Eastern Cape's renewable energy projects has created 18 132 jobs since its inception. The province was awarded 16 wind farms and one solar energy farm, with a total investment value of R33.7 billion. Rural development is also being positively impacted by the deployment of renewable energy technologies through the REIPPPP[28].

REIPPPP attracted billions in private investment, stimulating job creation, rural development, and knowledge transfer in the renewable energy. Limpopo can leverage of the future Bid Windows to help drive not just energy security but economic development within the province.

The Renewable Energy Development Zones of 2018

The REDz[29] sought to attract investment into the renewable energy sector by showcasing the potential and viability of these zones for renewable energy development, the goal was to stimulate interest and investment from both domestic and international sources. It also emphasized the importance of local economic development by creating opportunities for job creation, skills development, and socio-economic benefits within the communities hosting these renewable energy projects.

The wind industry embarking on a journey of localization and local economic development, with the belief that the eMalahleni REDZ can be positioned as a component manufacturing hub, which will further entrench the positive impact on job creation by the wind industry.

Although there has not been a REDz identified for Limpopo, the province can leverage of the Musina-Makhado Special Economic Zone (MMSEZ) to promote economic development.

[27] National Treasury. (2009, 2011). Feed-in Tariffs for Renewable Energy
[28] Department of Energy. (2011). Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)
[29] Department of Forestry, Fisheries and the Environment. (2022). Renewable Energy Development Zones (REDz) Guideline Document

National Energy Efficiency Strategy Post – 2015

The objective of the National Energy Efficiency Strategy Post-2015[30] regarding economic growth was multifaceted, aiming to reduced energy costs by improving energy efficiency across various sectors, the NEES sought to bring down overall energy consumption and associated costs for businesses and households. This, in turn, aimed to free up capital for other investments, boosting economic activity and competitiveness.

The reduction in energy use could lead to more efficient production processes, potentially lowering production costs and increasing output for businesses in addition, it aimed to stimulate the domestic market for energy-efficient technologies and services. This, to potentially attract new investment, create jobs in the clean energy sector, and contribute to the diversification of the South African economy.

Limpopo can contribute to achieving the targets set by the NEES by identifying sectors with high energy consumption potential like manufacturing, mining, agriculture, and public buildings. Implementing energy efficient technologies (i.e. energy efficient light bulbs etc.) in these sectors can help the province contribute to achieving the NEES targets. There is also potential for individuals and businesses to play a role in reducing the energy demand by investing in energy efficient technologies, however, this may be met with resistance as the cost purchasing of such technologies may be high.

The Carbon Tax Act of 2019

The objective of the Carbon Tax Act of 2019[31] was to incentivize businesses and industries that reduced their greenhouse gas emissions and adopted sustainable practices. Companies could receive allowances for a portion of their emissions, reducing their tax liability if they met specific benchmarks or targets.

Emission allowances range from 60% to 95% in this first phase. This includes a basic tax-free allowance of 60% for all activities, a 10% process and fugitive emissions allowance, a maximum 10% allowance for companies that use carbon offsets to reduce their tax liability, a performance allowance of up to 5% for companies that reduce the emissions intensity of their activities, a 5% carbon budget allowance for complying with the reporting requirements and a maximum 10% allowance for trade exposed sectors. The idea was that revenue generated from the carbon tax was intended to be recycled back into the economy through various mechanisms.

Given that the province is aiming to invest in renewable energy, it must be noted that renewable energy sources are replenished by nature and emit little to no greenhouse gases or pollutants into the air compared to fossil fuels however, renewable technologies have a small amount of carbon dioxide associated with their output due to the emissions from their manufacturing and installation. The Act makes provision for thresholds whereby Treasury has set a 10 MW installed thermal input capacity threshold for combustion activities that result in emissions before becoming liable, as wells as tax-free allowances (incl. off-set allowances).

Limpopo Development Plan 2020 – 2025

The Limpopo Development Plan 2020 – 2025[32] plan highlights that the fiscal framework for some municipalities, especially in rural areas, is unviable, posing a serious risk to their financial sustainability. It states that distributed generation through biomass, biogas and municipal waste are areas for great potential for improving municipal revenues.

[30] Department of Mineral Resources and Energy. (2015). National Energy Efficiency Strategy (NEES) (Post 2015)
[31] National Treasury. (2019). Carbon Tax Act (Act No. 52 of 2019)
[32] Limpopo Provincial Government. (2020). Limpopo Development Plan 2020-2025

It also highlights some of the key activities to conduct campaigns to encourage production of off-grid electricity by small (5 MW) solar power plants and encourage the production of components of solar panels (utilize silicon reserves and optimize the silicone smelter in Polokwane).

Limpopo Green Economy Plan (2013)

This plan also highlights the potential of solar panel production, referring to the large silicon reserves in Polokwane. Industrial enterprises to use the resource to create local employment and development of the human resource of the province. Production of solar chargers for cell phones, small scale electrical devises can be initiated, and franchise further developed. The province has favourable solar radiation and abundant land to build concentrated solar plants with generation, its geographic situation will allow transmission and sale to Zimbabwe, Botswana, Mpumalanga, Gauteng. The plan highlighted that the medium to long term goal will be to stimulate the development of new and renewable sources of energy through various mechanisms such as incentives.

Limpopo's Green Economy Plan (2013)[33] aimed to leverage the province's natural resources to promote sustainable economic growth through green s like renewable energy and eco-tourism.

2.6 The Electricity Regulation Amendment Bill 2023

The Electricity Regulation Amendment Bill 2023 was a proposed amendment to the Electricity Regulation Act of 2006[34]. It aims to introduce various changes to the existing regulatory framework governing the South African electricity sector and not necessarily repeal existing policies. However, it's important to note that the bill has not yet been passed into law.

Some of the potential amendments include a competitive electricity supply market, the introduction of key role players in the electricity sector, registration and licensing, NERSA's powers, pricing and tariffs and the Minister's role.

2.6.1 A competitive electricity supply market

At the core of the Bill lies the aspiration to create a competitive electricity market. The Bill enforces third party access to the transmission and distribution system based on published tariffs, applicable to all customers and applied objectively, without discrimination. Refusal by a licensee to grant access is only permissible when capacity limitations exist, accompanied by clear written justifications.

2.6.2 The introduction of key role players in the electricity sector

The following key role players are proposed to be introduced in the electricity sector:

- Transmitter: this role is tasked with overseeing infrastructure plans for the transmission network and the development and implementation of transmission use of system charges.
- System Operator: the System Operator has a multifaceted role, including the operation of the integrated power system. Furthermore, it is obligated to collaborate with the Minister and procurer to facilitate the establishment of new generation capacity or electricity transmission infrastructure.
- Market Operator: the Market Operator is required to provide a trading platform market, along with market rules and criteria.

[33] Limpopo Provincial Government. (2013). Limpopo Green Economy Plan
[34] Republic of South Africa. (2006). Electricity Regulation Act, 2006 (Act No. 4 of 2006)

- Central Purchasing Agency: this agency is responsible for the procurement of electricity, including ensuring sufficient capacity and energy supply.

This is in line with the unbundling of Eskom and the Energy Regulator has approved that the National Transmission Company (NTCSA) of South Africa be issued with a licence to operate a transmission system within the national boundaries of South Africa. The NTCSA will operate the transmission system and perform the following key integrated roles to ensure the integrity of the interconnected power system: transmission network service provider, system operator, transmission system planner, grid code secretariat.

2.6.3 Registration and Licensing

The Bill streamlines licensing requirements and introduces mandatory registration for activities not requiring licensing. Notably, facilities solely providing standby or backup electricity, those without a point of connection, and small-scale facilities under 100 kilowatts are exempted, provided they register with NERSA and comply with specific conditions.

2.6.4 NERSA's Powers

The proposed amendments empower NERSA further, granting it authority over a broader range of activities and giving it the power to issue, amend, withdraw, suspend, and revoke licenses. The registration, revocation, and deregistration of entities or activities will also be under its view.

2.6.5 Pricing and Tariffs

In a significant departure from the current approach under the Electricity Regulation Act (ERA) (2006), the Bill redefines NERSA's role regarding pricing. NERSA will no longer be required to regulate pricing but will take on the responsibility of setting and approving tariffs. This limits the municipalities' ability to determine their own tariffs which affects revenue and expenditure.

2.6.6 The Minister's Role

As currently provided for under section 34 of the ERA[35], which operates as the legislative framework by which the Minister is authorized to make determinations regarding the need for additional electricity or new generation capacity, any decision taken by the Minister in that regard has no force and effect unless NERSA agrees with the Minister's decision.

The Bill vests the power in the Minister solely (after consultation with the Minister of Finance and NERSA, and by notice in the gazette) to decide in relation to additional electricity and new generation capacity to ensure the uninterrupted supply of electricity. This authority can be invoked in cases of market failure, emergencies, or national interest.

It is anticipated that the Bill will provide for much needed change in the electricity sector, promoting the growth of independent power producers to compete with Eskom.

[35] Republic of South Africa. (2006). Electricity Regulation Act, 2006 (Act No. 4 of 2006)

2.7 Key Considerations

It is essential to consider all elements within the renewable energy value chain to support the effective execution of a resilient and prosperous strategy, with that, several limitations with potential solutions have been identified. These include issues regarding permit processes, grid constraints, financing, skills development and community involvement (Figure 6).

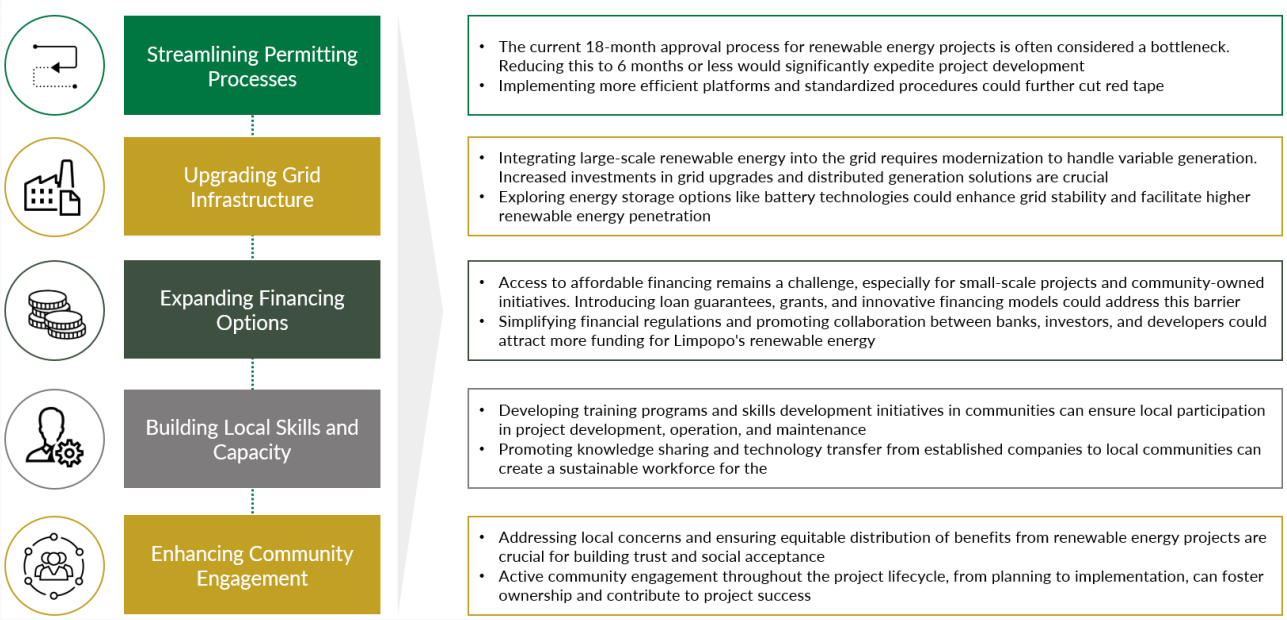


Figure 6: Constraints relating to renewable energy adoption

2.7.1 Grid infrastructure

Achieving the above may be difficult due to the grid constraints experienced in South Africa, however, Eskom has outlined a comprehensive plan for expanding the country's electricity transmission network between 2023 and 2032 (Figure 7).

The plan, as outlined in Eskom's Transmission Development Plan (TDP), is divided into two phases. The first phase, spanning from 2023 to 2027, prioritizes the construction of 2 893 km of new transmission lines. This initial phase is estimated to cost R48 billion and is likely focused on addressing immediate grid capacity limitations and connecting new generation projects to the national grid[36][37].

The second phase, to take place between 2028 to 2032, represents a more substantial expansion. Eskom plans to construct a significantly larger network of 11 325 km of transmission lines during this period. This build-out reflects the long-term vision for the grid and is likely driven by factors such as strengthening existing infrastructure and supporting anticipated growth in electricity demand across the country. The estimated cost of this second phase is R187 billion and will be required to occur at a rate that is eight times the rate of the build-out that occurred during 2017 to 2022[38].

[36] Better Finance, Better Grid – Prof Mark Swilling
[37] Transmission Development Plan
[38] Centre for Sustainability Transitions (2023)

The total planned build-out over the ten-year period is 14 218 km. This significant investment of R235 billion highlights Eskom's commitment to reinforcing the national grid's capacity and resilience (Figure 7).

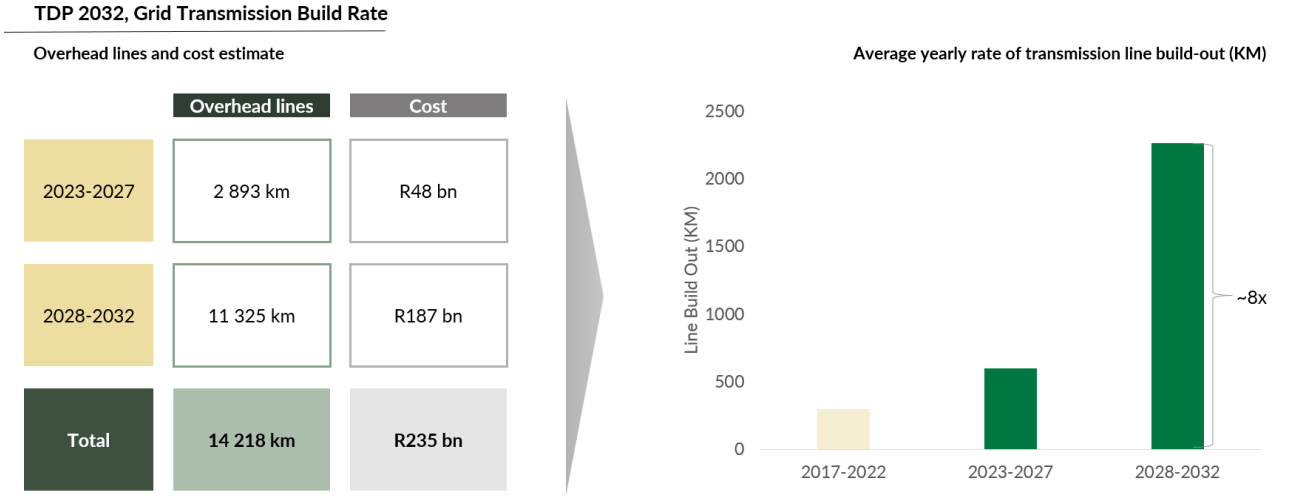


Figure 7: Grid transmission build rate as per Eskom's Transmission Development Plan, 2032

Additionally, Eskom has indicated grid strengthening plans for Limpopo aimed to address two key challenges, load growth and generation integration. To meet the rising demand, Eskom intends to expand the grid by constructing new overhead power lines. Figure 8 details the twelve specific projects, including the routes and estimated costs. These projects aim to deliver electricity from generation sources to areas of high demand within Limpopo. The overhead lines from Borutha substation to Nzhelele is the longest at 226.40 kms at a cost of R 3.76 billion. The total cost of all twelve projects is estimated at R 24 billion, covering 1 423 km[39].

The other challenge Eskom is addressing is generation integration. Eskom's Transmission Development Plan (TDP) acknowledges the need to integrate renewable energy sources into the national grid. By constructing new transmission lines, Eskom can ensure that electricity generated from these new sources can be fed into the provincial grid and distributed to consumers. The grid strengthening plans are crucial for ensuring a reliable and secure electricity supply in Limpopo. Expanding the grid will accommodate increasing demand for electricity, while integrating new generation sources will diversify the province's energy mix and contribute to a more sustainable future.

[39] Transmission Development Plan

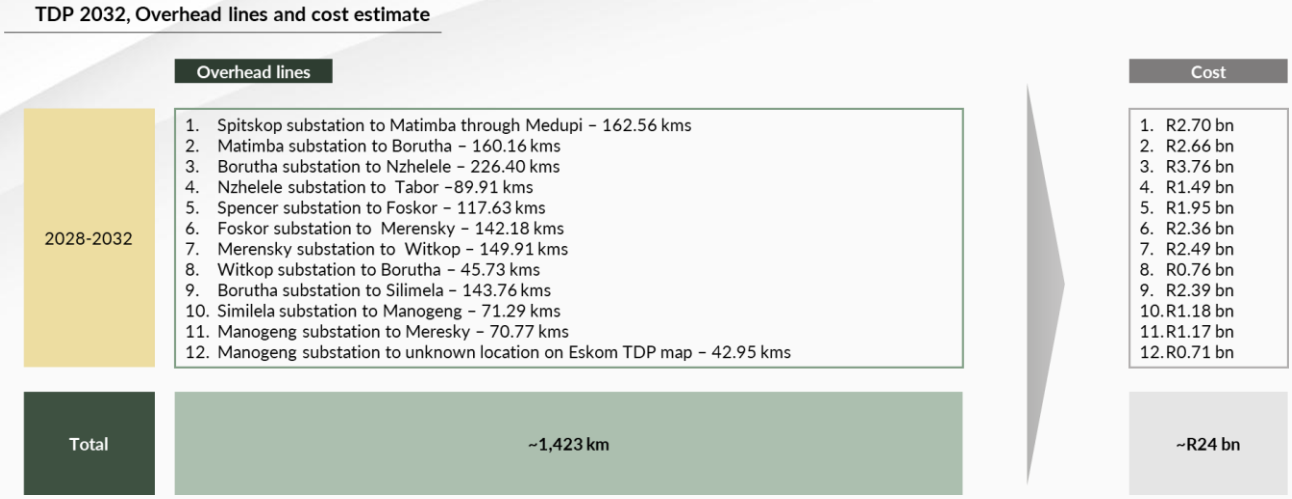


Figure 8: Overhead lines and cost estimate for Limpopo as per Eskom's TDP, 2032

2.7.2 Grid constraints and access

Existing grid infrastructure in Limpopo may not be able to handle the influx of large-scale renewable energy projects, causing bottlenecks and delays. This may be future impacted by complex and lengthy grid connection procedures which can delay project development, particularly for smaller players. A future consideration is that remote rural areas in Limpopo might lack adequate grid infrastructure, limiting their access to the benefits of renewable energy.

However, nationally Eskom has indicated that there are currently 46 expansion projects in execution, of which 26 will deliver 1 632km of transmission lines, 11 290 MVA and enable over 15 000 MW of generation capacity. In addition to this, Eskom has approved the execution of R26 billion in capital investment for transmission, with two priority programs already in the pipeline to accelerate the delivery of the transmission infrastructure. These programs entail, firstly, the development of 25 projects in existing substation which will unlock 13 000MW of new generation in the next five years and secondly, 22 expedited transmission projects that will unlock 24 000MW of grid connection capacity by 2033.

With regards to Limpopo province, during the Department of Public Works and Infrastructure Budget Vote 2023/24, Minister Sihle Zikalala indicated that the department processed 27 requests from Eskom for expropriation of private land parcels to enable the construction of key transmission power lines in the province. According to the Eskom TDP (2019 -2029)[40], the capital expenditure for expansion projects in Limpopo is R 12.4 billion for the for the FY2020 to FY2029.

The major TDP schemes planned in Limpopo consists of the establishment the 765 kV network (operated at 400 kV), integration of the Medupi Power Station, and extension of the 400 kV and 275 kV networks, which entail installation of additional transformers at existing and new substations. A summary of the major schemes include:

- **Medupi transmission integration (400 kV and 765 kV):** The project is part of the original scope for Medupi Power Station integration into the grid. It entails the construction of the 400 kV and 765 kV lines from the vicinity of Medupi Power Station to bulk power evacuation points in Polokwane CLN and North West.

- **Waterberg generation 400 kV stability enhancement:** These projects were recommended due to future planned generation projects around the Waterberg area. The projects were raised to ensure

[40] Eskom. (2023). Eskom Transmission Development Plan (TDP) 2023 – 2032

compliance with the Grid Code in terms of transient stability. These include the construction of 1 x 400 kV line from Medupi to Witkop (~200km) and 1 x 400 kV line from Borutho to Silimela (~100km).

- **Nzhelele 400 Kv integration:** Expand Nzhelele 132 kV distribution SWS to a 400/132 kV main transmission system.

- **Limpopo East Corridor Strengthening**: Building a new 110 km 400 kV line from Foskor Substation to Spencer Substation and the establishment of 400/132 kV transformation at Spencer Substation. The project will also require the 2nd Merensky - Foskor 275 kV line to be operated at 400 kV. A new 400/275 kV transformation will be established at Foskor Substation.

- **Silimela Transmission Substation:** A new transmission substation will be constructed next to the existing Wolwekraal distribution substation to mitigate network constraints in the Mapoch and Kwaggafontein areas beyond 2019. This new transmission substation will deload Simplon substation and supply the long-term future load growth in the south-western part of the Phalaborwa.

- **Sekhukhune Transmission Substation:** A new Transmission substation will be constructed near Uchoba distribution substation to create additional transmission network capacity for forecasted future load growth in the Steelpoort area.

- **Dwarsberg (Dwaalboom) 132 kV Switching Station:** A 132kV switching station will be established to improve performance of the supply to existing Eskom customers in the Dwaalboom area, as well as the supply to Gaborone area in Botswana.

2.7.2 Regulatory and financial uncertainties

Frequent changes or inconsistencies in renewable energy policies can create uncertainty and discourage investment. In addition, to the lack of sufficient financing mechanisms or feed-in tariffs which can make renewable energy projects less attractive compared to traditional fossil fuels. Another issue to be considered is complicated permitting processes and bureaucratic hurdles which can delay project approvals and increase investment costs.

The Medium-Term Budget Policy Statement (2023)[41] highlighted that the infrastructure environment has several challenges that hinder efforts to fast-track delivery. In addition, some challenges include the lack of a credible pipeline that can attract funding, lack of sustainable financing arrangements to crowd-in private finances, and poor contract and project management to manage cost and schedule overruns.

To assist with this, there is going to be an amendment to Treasury Regulations and key elements of municipal legislation in line with the recommendations of the completed review of the Public Private Partnerships framework which will be published by the time of the Budget 2024.

National Treasury is also establishing an Infrastructure Finance and Implementation Support Agency that will systematically address the need to crowd-in private sector finance and expertise into the public infrastructure programme. The government will widen the scope for concessional borrowing by creating new mechanisms through which private-sector investors and multilateral institutions can co-invest with government for selected infrastructure projects. This will include the use of build-operate-transfer (BOT) structures, PPPs and concessions, and application of the frontloading mechanism which provincial conditional grants now allows for.

[41] National Treasury. (2023). The Medium-Term Budget Policy Statement

The outcome will be clearer institutional arrangements for the private sector to invest in public infrastructure, an increased pipeline of credible infrastructure projects, and greater access to various forms of financing underpinned by effective delivery mechanisms. These measures will unlock social infrastructure projects, blended finance and PPPs including the electricity transmission infrastructure amongst other projects that will be fast tracked. It was indicated that further details will be provided in the 2024 Budget.

Additionally, the 2023 Budget provides tax relief totalling R13 billion to support the clean energy transition, increase electricity supply and limit the impact of consistently high fuel prices. A total of R4 billion in relief is provided for households that install solar panels, R5 billion is provided to companies through an expansion of the renewable energy incentive.

In 2023, the Minister of Trade, Industry and Competition announced two initiatives to tackle the energy shortage: the Energy One-Stop Shop (EOSS)[42] and the Energy Resilience Fund. The EOSS is a streamlined system designed to speed up approvals for new energy projects, especially renewable energy projects. This will help increase the amount of electricity available on the grid more quickly. The EOSS addresses a major pain point for energy developers which is the complex approval process often slowing down projects.

At a provincial level, businesses can benefit from tax incentives as outlined in the 2023 Budget. Currently, businesses can deduct the cost of qualifying renewable energy investments (wind, solar, biomass, etc.) over three years, with varying percentages deducted annually. For instance, 50% could be deducted in year one, followed by 30% and 20% in subsequent years. Smaller solar projects (<1MW) even allowed for a complete first-year deduction. Under the new measure, it will allow a 125% deduction in the first year for all renewable energy projects, regardless of size or technology. This applies to investments commissioned between March 2023 and February 2025, offering a limited-time window for accelerated tax benefits.

To further incentivize renewable energy adoption and bolster electricity generation, the government has introduced a temporary rooftop solar incentive specifically for individuals. This initiative allows homeowners to claim a 25% tax rebate on the cost of new and unused solar photovoltaic panels installed at their residences between March 1, 2023, and February 29, 2024. Qualified individuals can claim the rebate against their personal income tax liability for the 2023/24 tax year, with a maximum benefit of R15,000 per individual.

2.7.3 Land use and community challenges

It is important to note that potential competition for land between renewable projects and agricultural or other activities can lead to community opposition and delays. Therefore, inadequate consultation and involvement of local communities in decision-making processes can create resentment and resistance to projects. The implementation of the strategy may be further impacted due to a lack of community ownership models or insufficient benefits sharing mechanisms that exclude local communities from the economic benefits of renewable energy.

The Spatial Planning and Land Use Management Act (SPLUMA)[43], enacted in 2013, plays a crucial role in shaping land use decisions in South Africa, including those pertaining to renewable energy projects. Its aims directly impact the potential success of such projects by promoting efficient land use, fostering equitable development, encouraging intergovernmental cooperation, and establishing guiding principles for sustainable development. SPLUMA encourages the efficient and sustainable utilization of land resources. This means identifying areas suitable for renewable energy projects while carefully considering environmental and social factors. Additionally, the Act prioritizes inclusive and equitable spatial planning, aiming to address historical

[42] Department of Trade, Industry and Competition. (2023). One Stop Shop and Energy Resilience Fund to Mitigate Impact of the Energy Crisis
[43] Department of Justice and Constitutional Development. (2013). Spatial Planning and Land Use Management Act (Act No. 16 of 2013)

inequalities and ensure that disadvantaged communities benefit from the development of renewable energy infrastructure. While SPLUMA itself does not directly allocate land for specific uses like renewable energy, it empowers various planning instruments, such as Spatial Development Frameworks and Land Use Schemes (LUS), to guide such decisions. Local authorities can incorporate renewable energy needs within these frameworks, identifying suitable areas with minimal environmental and social impact, considering factors like grid infrastructure, resource availability, and community involvement.

The Renewable Energy Development Zones[44] initiative by the government aimed to streamline and accelerate large-scale solar and wind energy project development. Launched in 2018, the program identifies 11 specific geographical areas with exceptional renewable energy potential based on wind and solar resource availability, grid capacity, and environmental constraints. This designation prioritizes these areas for infrastructure investment and environmental permitting, easing the path for developers. Importantly, REDZs don't pre-emptively allocate land; developers still engage in individual land acquisition processes that adhere to existing regulations and community consultations. While facilitating faster, larger-scale development, REDZs aim to minimize environmental and social impacts by concentrating projects within designated zones and ensuring responsible land use practices.

There has been assistance from Eskom regarding land for renewable energy projects. Eskom has signed lease agreements with four independent power producer investors for the use of land parcels worth R40-billion in investments. The land, owned by Eskom, is located around the Medupi and Tutuka coal-fired power stations in Mpumalanga. The lease agreements were awarded to HDF Energy South Africa, Red Rocket SA, Sola Group and Mainstream Renewable Power Developments South Africa to construct new, clean-energy generation capacity. The four investors will lease a total of 6 184 hectares of land for 30 years each and will contribute at least 2 000MW to the national electricity grid.

The Limpopo Green Economy Plan[45] recognized the province's potential for renewable energy development, particularly the availability of land. As a result, this has translated into several major solar projects notably:

- The 75-hectare Witkop Solar Park in the Caprion District
- The 180-hectare Soutpan Solar Park in the Blouberg District
- The 148-hectare Tom Burke Solar Park in the Waterberg District

However, responsible land acquisition is essential for such developments. Acquiring land for renewable energy projects in Limpopo requires adherence to several key policies and regulations including SPLUMA[46] which establishes the overarching framework for spatial planning and land use decisions, ensuring projects align with regional and provincial development plans, the National Environmental Management Act (NEMA)[47], which includes Environmental Impact Assessments which assess the potential environmental and social impacts, guiding responsible land use practices and minimizing negative consequences and the Expropriation Act which outlines the legal framework for land acquisition in exceptional circumstances, prioritizing fair compensation and adherence to due process.

In addition to the above, a key priority should be the involvement of local communities in the decision-making processes. It is important that local communities are not excluded from the economic benefits of renewable energy. At the national level, South Africa recognizes the importance of community involvement in its renewable energy transition. Policies like the REIPPPP[48] mandate developers to engage with affected communities during project planning and operation. The program had tasked REIPPPP to contribute towards

[44] Department of Forestry, Fisheries and the Environment. (2022). Renewable Energy Development Zones (REDz) Guideline Document
[45] Limpopo Provincial Government. (2013). Limpopo Green Economy Plan
[46] Department of Justice and Constitutional Development. (2013). Spatial Planning and Land Use Management Act (Act No. 16 of 2013)
[47] Republic of South Africa. (1998). National Environmental Management Act, 1998 (Act No. 107 of 1998)
[48] Department of Energy. (2011). Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

local community development through socio-economic and enterprise development, local ownership and local job creation. These requirements had to be fulfilled within a 50km radius of the project and oblige renewable energy companies to engage with the developmental opportunities and needs of communities around their project sites. Furthermore, NEMA requires public participation in EIAs, ensuring community voices are heard regarding potential environmental and social impacts. Additionally, SPLUMA advocates for inclusive spatial planning, encouraging community participation in shaping local development plans that incorporate renewable energy projects.

2.7.4 Skills and capacity challenges

Communities and businesses in Limpopo may lack awareness of the benefits of renewable energy and the technical skills for project development. A shortage of skilled professionals in renewable energy technologies can hinder project development and maintenance. This was highlighted as one of the key points in the South African Renewable Energy Masterplan (SAREM) (2022)[49] where former coal employees can be trained to pivot existing skills towards new job opportunities. It was also noted in the Limpopo Development Plan 2020 – 2025 and the Limpopo Green Economy Plan (2013) that skills development is essential.

The Energy and Water Sector Education and Training Authority (EWSETA)[50], a statutory body established in terms of the Skills Development Act of 1998 has a mandate to promote and oversee the development and implementation of skills development initiatives in the energy and water sectors in South Africa. For example, EWSETA, together with the Department of Higher Education and Training and the United States Agency for International Development on had launched a renewable energy skills development program for 100 women. The program aimed to provide valuable renewable energy industry skills, such as wind and solar system design and installation, battery storage design and installation, as well as solar water heating installation.

In addition, the program also focused on the upskill of 15 technical vocational education and training (TVET) college lecturers from the Gert Sibande, Nkangala and Ehlanzeni TVET in Mpumalanga, which would assist the colleges attain the required accreditation to offer a National Qualification Framework Level 3 qualification in electrical engineering for renewable energy. The lecturers will be capacitated not only on the course curriculum, so that they can train future cohorts, but also on the new renewable energy technologies that young learners today need to be exposed to.

EWSETA plays a critical role in ensuring that the energy and water sectors have the skilled workforce they need to meet the challenges of the future. The authority works closely with a wide range of stakeholders, including government, employers, education and training providers, and workers, to develop and implement effective skills development initiatives.

Another initiative is the proposed development of a South African Energy Skills Roadmap to support the JET. This development is in partnership with the South African National Energy Association, the Wits Business School's African Energy Leadership Centre, the University of Witwatersrand's Centre for Researching Education and Labour with the support of the South African BRICS Business Council and funded by Deutsche Gesellschaft für Internationale Zusammenarbeit. The aim of the South African Energy Skills Roadmap is to:

- Predict future skill needs for renewable energy jobs
- Bridge the gap by developing relevant training programs
- Identify declining areas and their affected workforces

[49] Department of Mineral Resources and Energy. (2022). South African Renewable Energy Masterplan (SAREM)
[50] Energy & Water Sector Education and Training Authority. (2023). Strategic Plan 2023 - 2025

- Design strategies to reskill these individuals for new opportunities, ensuring a smooth and equitable transition for all

At the provincial level, the Limpopo Department of Economic Development, Environment and Tourism (2022)[51] highlights potential programs to assist in building capacity and skills in the energy sector. For example, the Energy Management Systems Program which is aimed at creating a pool of Energy Management and Energy efficiency experts within the province. It intends to contribute towards the department in its effort to address climate change through its Limpopo Green Economy Plan. The program has, from the previous years, proved to be effective and has benefited many young engineering graduates in the province. Energy efficiency skills are in shortage in the province and as a result the province outsources from provinces like Gauteng. Developing a pool of local skills will fast track the plan of the province to create skills for the economy, specially within the green space.

[51] Limpopo Department of Economic Development, Environment and Tourism (2022)

3 BASELINE ASSESSMENT

3.1 Introduction

The baseline assessment was conducted to understand the current energy landscape in Limpopo. It incorporates stakeholder engagement inputs which were attained during the workshops held in February and March of 2024 across the five districts in the province. In addition, this section covers global energy trends and analyses the specific context of the regional and South African energy landscapes. This is followed by a comprehensive examination of Limpopo's current energy landscape offering a granular picture of energy consumption patterns across various sectors. A SWOT analysis as well as an overview of the renewable energy value chain is included in this section.

3.2 Key questions for consideration

In essence, the baseline assessment will seek to answer the following questions:

1. What are the international trends and recent market developments in the use of renewables for new generation, in markets comparable to South Africa?
2. What are the regional trends and recent market developments in the use of renewables for new generation?
3. What is the status of current state of renewables primary sources in South Africa that could impact the renewables strategy implementation? What is the status of, and outlook for, the associated infrastructure for these sources?
4. What is the status of current state of renewables primary sources in Southern Africa that could impact the renewables strategy implementation? What is the status of, and outlook for, the associated infrastructure for these sources?

The answers to these questions will inform provincial norms and standards as well as the energy needs assessment and intervention strategy.

Additionally, we will answer for the following questions to inform the next phase of our analysis:

1. Continue to access the status of the national and provincial plans related to renewables, including the revisions to the Integrated Resource Plan (IRP), and other related plans, and how are these expected to progress (direction and timescales)?
2. Continue to access the impact of other policies and legislation that have significant bearing on the role of renewables in new power generation and impact on climate change?
3. Who are the main actors and influencers in the renewables sector, and what is their relative positioning on the matter more so on the value chain? How can municipalities reduce dependency on Eskom?
4. How can Limpopo play a role to promote economic development through investment and create a conducive regulatory environment for renewable energy generation more so for municipalities and IPPs?
5. How can Limpopo support speedy processes in renewable energy projects and promote local participation in the value chain, including local content manufacture?

The answers to these questions will inform the implementation action plan and monitoring and evaluation framework, institutionalization, and capacity building framework and essentially, Limpopo's renewable energy strategy.

3.3 Stakeholder Engagement Inputs

The stakeholder engagements for Limpopo's renewable energy strategy creation are crucial for its success for several reasons. Firstly, the diverse perspectives offered by different stakeholders provide a comprehensive understanding of the potential benefits and challenges associated with renewable energy. Secondly, stakeholder engagement fosters a sense of ownership and commitment, which is essential for the successful implementation of any proposed solutions. Lastly, it ensures transparency and promotes trust among all parties involved, thereby facilitating more effective decision-making processes. An in-depth analysis of the stakeholder engagement report can be found in Annexure A.

3.3.1 Overview of stakeholder engagements

To gather insights from the stakeholders, a systematic methodology was used. We began by identifying stakeholders through stakeholder mapping. Following this, the stakeholders were sent invitations and a day before the meeting agenda was circulated. During the meeting, key actions and points were noted. If stakeholders promised to provide additional documents or data, follow-up actions were taken to ensure these resources were received. This process ensured a comprehensive understanding of all District stakeholder perspectives which contributed significantly to the findings.

The stakeholder engagements took place at each of the five districts, starting with Vhembe on the 27th of February 2024 and ending with Mopani on the 8th of March 2024 as per Figure 9 below.

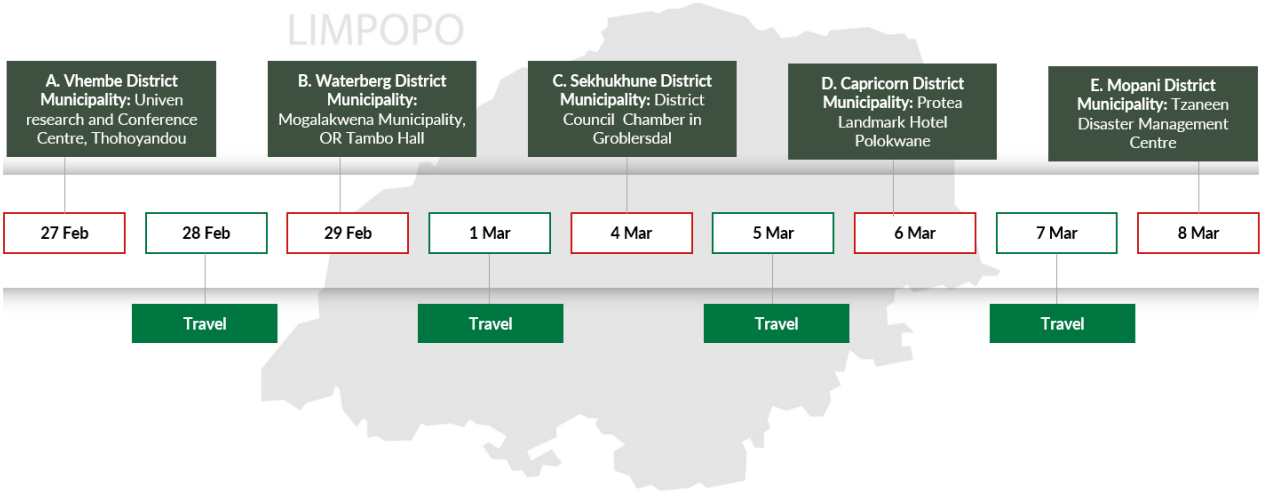


Figure 9: Dates for district engagements

The workshop employed a well-defined schedule, fostering a collaborative environment for exploring Limpopo's renewable energy transition. The day was segmented into presentations, facilitated discussions, and refreshment breaks. Following introductions and project overviews, a policy analysis of the current energy landscape provided context. A facilitated discussion allowed participants to offer initial feedback on the presented information. With discussions centred around our key core themes as defined by Figure 10 below.

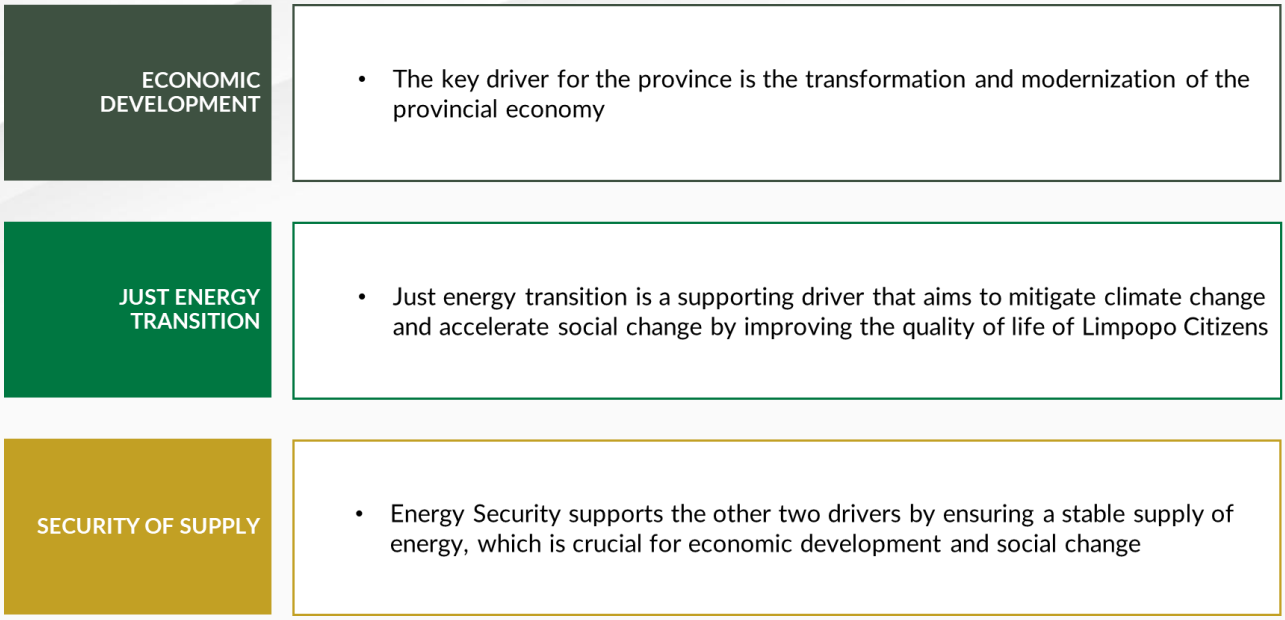


Figure 10: Three core themes

The participants were then divided into groups for the sessions. Each session had different questions, relating to the three themes of energy security, economic development and just energy transition considering the specific district profiles (Table1).

Session 1:

1. What are the current energy problems the district is facing?
2. What are the root causes of these problems?
3. What role can renewables play in solving these problems?

Session 2:

1. What bottlenecks can be unlocked to create the strategy?
2. How can we work together solve for these problems?
3. What capacity is needed to enable for interventions to work?

Table 1: District profiles

Area of interest	District specific information
Demographics	• Population growth witnessed in the Vhembe, Waterberg, Capricorn and Mopani districts. With average growth between 0.2 – 0.4 million is all districts • Growing populations means there is the potential for greater energy demand which puts pressure on energy infrastructure present in districts • Aging populations only seem to exist in the Vhembe district, whereas the other 4 districts present youthful population
Infrastructure and energy mix	• **Vhembe:** 17 substations, with more like Lambani and Tshilamba under construction to boost capacity • **Waterberg:** Gas usage at 15%. Electricity usage from 60% to 93%. Firewood with 40% and 30% usage • **Sekhukhune** Substation project, which is a new substation, will be operated by Eskom Holdings SOC. • **Capricorn**: Witkop Solar is a 30 MW (AC) solar PV project located • **Mopani:** several infrastructure upgrades regarding: Electricity connections, repairs and maintenance on prepaid meters and infrastructure
Economic sectors	• **Vhembe:** Food, Beverage Value Addition and Processing contributing 20-30% employment • **Waterberg:** Mining = pivotal economic contributes over 50% of district's income • **Sekhukhune:** Mining and trade are key sectors with both contributing 20% to income and 41% to informal employment in the district • **Capricorn:** Community services sector biggest contributor to district and its income – 30.9% contribution • **Mopani:** mining accounts for 30.1% of the economic sector
Investment opportunities	• **Vhembe:** strategic location near Zimbabwe, Mozambique, and Botswana, MMSEZ with infrastructure to support sectors such as mining, energy, and manufacturing, Venetia diamond mine offers investment opportunities in the mining sector • **Waterberg**: opportunity lies in the infrastructure development for agro-processing sector • **Sekhukhune:** FTSEZ focuses on developing a metallurgical cluster = opportunities for mining • **Capricorn:** Blouberg Irrigation Pipeline • **Mopani:** Mining (Ba-Phalaborwa) and rival of old mines in Giyani
Educational development	• **All districts:** Trend toward higher educational attainment, increases in Matric completion and higher education • This could give rise to development of targeted education programmes and vocational training aligned with the renewable energy industry's needs
Challenge and initiatives	• **All districts:** are faced with aging infrastructure, cable theft, load shedding, illegal connections, and meter tampering • These issues threaten electricity supply reliability and quality, affecting economic growth and resident well-being

3.3.2 Insights from the engagements

The workshops for the development of a renewable energy strategy for Limpopo in various districts yielded crucial insights and provided clarity about challenges they are currently facing. All the districts face significant hurdles such as load shedding, causing adverse effects on employment, education, and the health sector, as well as disruptions in agriculture. The operational disturbance in farming, high costs of alternative energy sources, and limited funding further exacerbate the challenges. Additionally, issues like poor maintenance, geopolitical tension, and a lack of technical skills hinder progress. With common discussion points being identified as per Figure 11. Detail outputs from each of the district is presented in Annexure A.

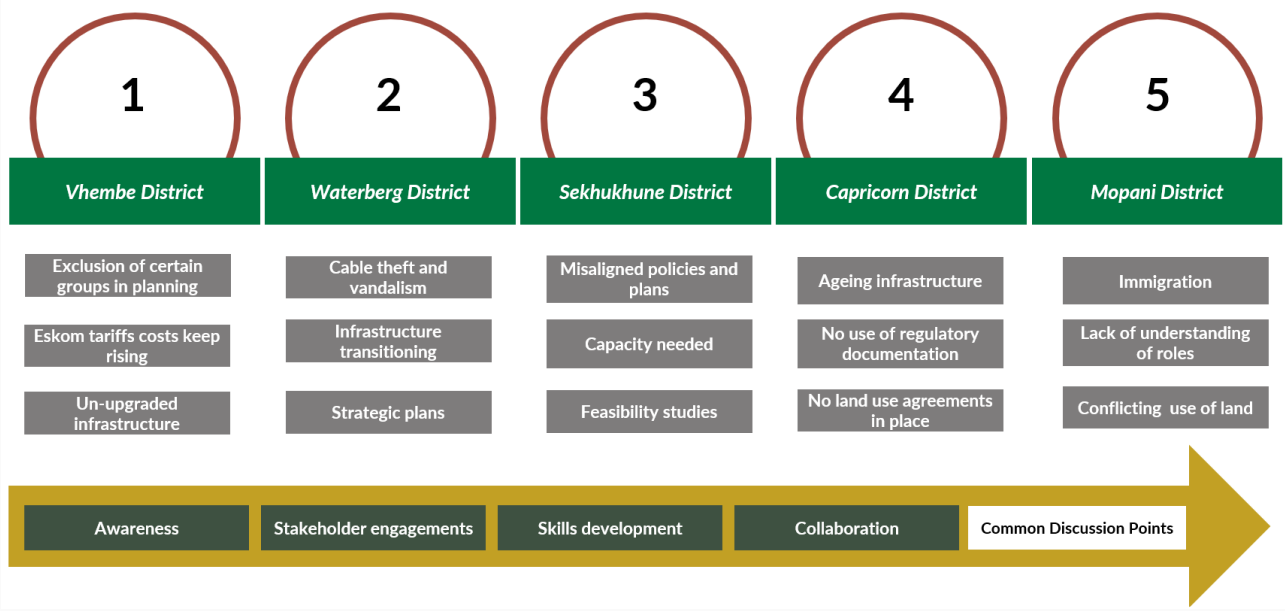


Figure 11: Key stakeholder inputs

Table 2 provides more details on the matters raised during the engagements.

Table 2: Key points raised in the stakeholder engagements

Key points	Description
Cable theft and vandalism	Ensuring the preservation of infrastructure may pose challenges due to issues such as vandalism, cable theft and illegal electricity connections
Infrastructure transitioning	Infrastructure takes time to transition and there will be a need to utilise Eskom's current infrastructure base
Misaligned policies and plans	There was a general viewpoint of general misalignment of policies across all spheres of government
Capacity needed	There is a need for adequate change management mechanisms; as well as organisational structure dedication

Use of land	There is a possibility of utilising landfill sites for gas generation; Concerns raised pertaining to the provision of PTO (Permission to Occupy) by traditional leaders – however investors need title deeds instead of PTO for land use – Waterberg (Agricultural land)
Regulatory documentation for renewable technology	Establishing licensing and regulations for renewable energy technology
Awareness	Educating and raising awareness within the communities about renewable energy, its benefits and how it will impact the livelihoods of communities positively
Stakeholder engagements	Stakeholder engagements are critical at all levels from community, academic, private and public sector
Skills development	Building capacity for disposal, trade, and manufacturing; Curriculum development for renewable energy courses (Vhembe emphasized FETs playing this role, and Mopani emphasized TVET Colleges playing this role)
Collaboration	Encouraging public participation and providing feedback to the participants; Collaboration should be prevalent in land use agreements as this plays a crucial role in implementing Solar PV infrastructure

3.4 Situational Analysis

The situational analysis for the Limpopo renewable energy strategy delves into the province's energy landscape across various scales. This multi-tiered approach provides a comprehensive understanding of the context in which the strategy will be implemented. We examine the global energy landscape, exploring trends and developments. Additionally, the analysis considers the regional context, examining the energy situation of neighbouring countries with an analysis on the South African energy landscape, before focusing on Limpopo itself, analysing the province's current energy use, existing renewable energy resources, and any internal strengths and weaknesses that may assist with the development of the strategy.

3.4.1 Global Energy Trends

The Earth's surface temperature has been on a rising trend since 1985 (Figure 12), with the warming primarily attributed to human activities, particularly the burning of fossil fuels[52]. This combustion process releases significant amounts of carbon dioxide (CO_2) into the atmosphere, trapping heat and causing global temperatures to rise[52]. The Intergovernmental Panel on Climate Change (IPCC) has indicated that under various scenarios, we can expect global temperature anomalies to reach 1.5°C by 2040[53].

[52] CO_2 and Greenhouse Gas Emissions - Our World in Data (2023)
[53] IPCC - Intergovernmental Panel on Climate Change (2023)

In response to this growing concern, the international community has established a series of policies to combat climate change. These efforts began with frameworks for cooperation, like the United Nations Framework Convention on Climate Change (UNFCCC)[54]. As scientific understanding solidified, these policies evolved to include specific reduction targets, as outlined in the Kyoto Protocol. Most recently, the Paris Agreement established ambitious global temperature goals to curb climate change[55]. These international efforts highlight the urgency of addressing rising CO_2 emissions and transitioning towards cleaner energy sources.

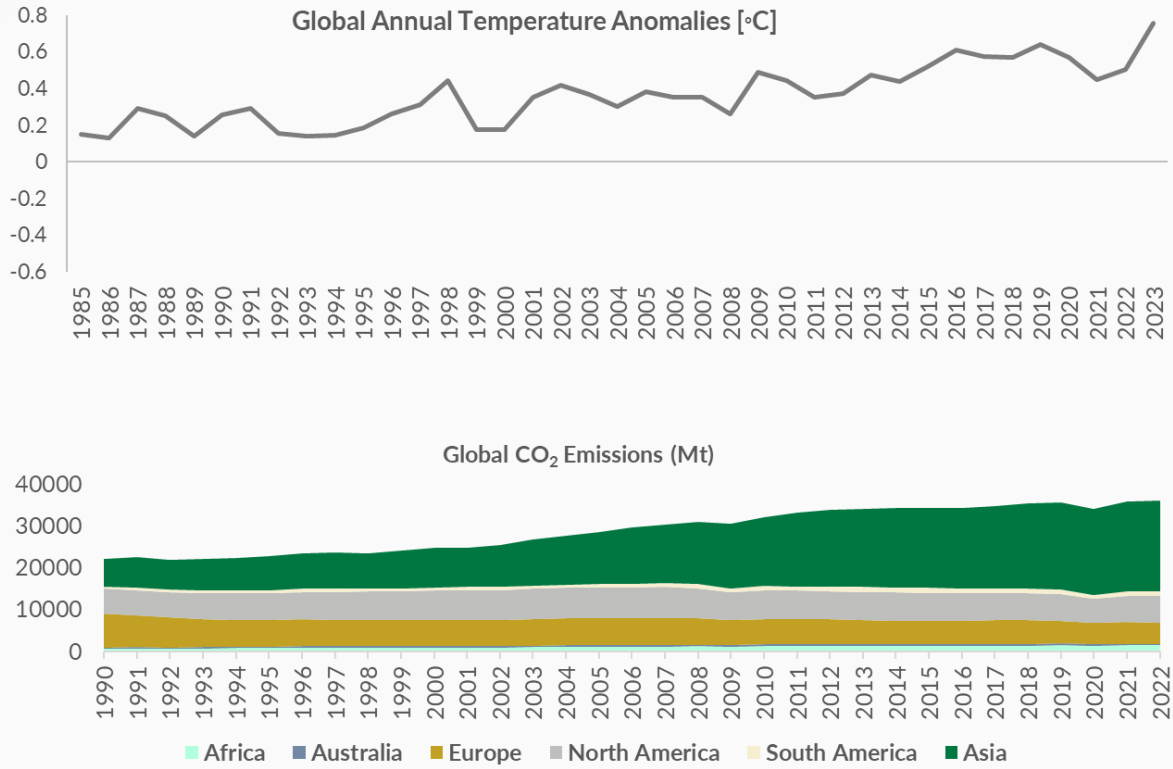


Figure 12: Global increase in annual temperature anomalies and CO2 emissions[56][57]

In response to the escalating threat of climate change, driven by rising CO_2 emissions from fossil fuel consumption, a multi-pronged approach has emerged. Carbon taxes have been implemented to financially incentivize a shift away from fossil fuels by putting a price tag on carbon emissions. Additionally, the concept of Environmental, Social, and Governance (ESG) investing has gained traction. This approach encourages investors to consider a company's environmental impact, social responsibility, and governance practices alongside traditional financial metrics, recognizing the long-term value of sustainability. Finally, the Sustainable Development Goals (SDGs) established by the United Nations aim to address global challenges like climate change[58]. Goal 13 specifically targets combating climate change and its effects, highlighting its interconnectedness with all other aspects of sustainable development[59]. These combined efforts demonstrate a global commitment to transitioning towards a cleaner, more sustainable future.

[54] United Nations: Climate Change (2023)
[55] Britannica Encyclopaedia (2024)
[56] CO_2 and Greenhouse Gas Emissions - Our World in Data (2023)
[57] IPCC - Intergovernmental Panel on Climate Change (2023)
[58] United Nations: Climate Change (2023)
[59] Britannica Encyclopaedia (2024)

Investments into Clean Energy

Global investment in clean energy has increased significantly in recent years, while investment in fossil fuels has decreased. This trend is likely due to several factors, including the increasing cost-competitiveness of clean energy sources such as solar and wind power, as well as growing concerns about the environmental impact of climate change.

According to the International Energy Agency (IEA), clean energy investment reached a record high of $1.7 trillion in 2023, while investment in fossil fuels fell to $1.1 trillion (Figure 13)

The IEA states that the growth of clean energy investment is being driven by several factors, including government policies that support clean energy, falling costs of renewable energy technologies, and increasing corporate demand for clean energy[60] [61].

The shift towards clean energy is essential to meet climate change goals. Figure 12 shows a significant increase in solar investment compared to oil production investment. In 2013, global oil production investment was at $636 billion, whereas solar investment was at $127 billion[62]. By 2023, solar investment had risen to $382 billion, while oil production investment had fallen to $371 billion with the Compound Annual Growth Rate (CAGR) of 12% between 2013 and 2023 for solar[63]. This trend suggests a shift away from fossil fuels and towards renewable energy sources.

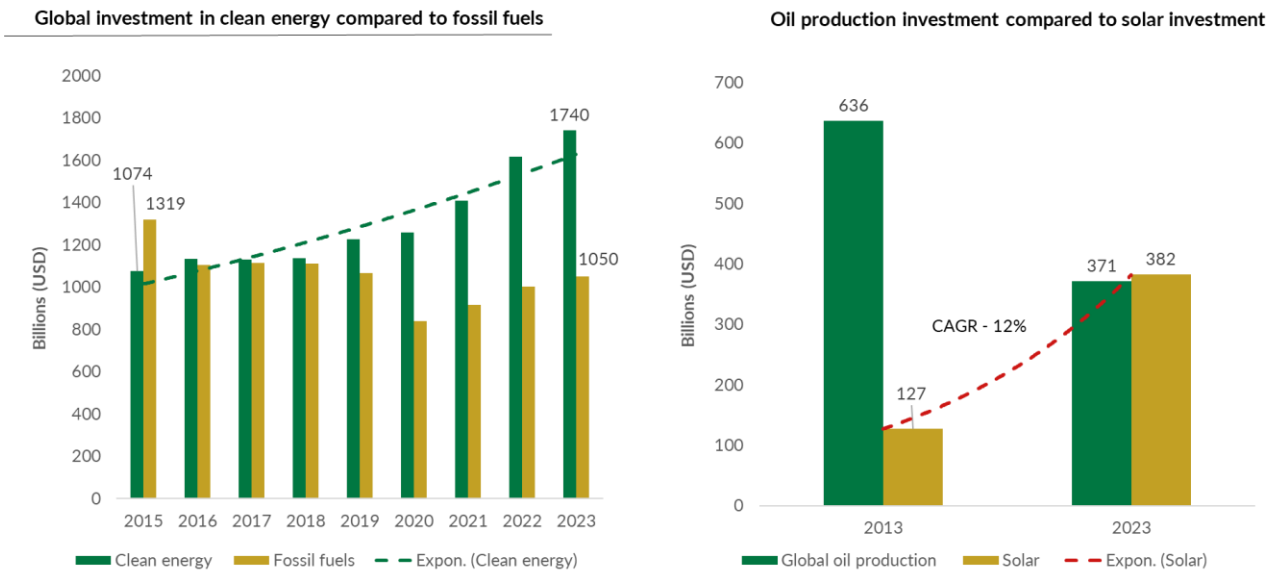


Figure 13: Global investments in fossil fuels and clean energy[64][65]

Fossil Fuel Spot Price and Global Inflation

[60] International Energy Agency (2023)
[61] Africa International Advisors (AIA) Analysis
[62] International Energy Agency (2023)
[63] International Energy Agency (2023)
[64] International Energy Agency (2023)
[65] Africa International Advisors (AIA) Analysis

Data suggests a clear correlation between rising spot prices for fossil fuels and global inflation in recent decades (Figure 14)[66][67]. This phenomenon can be attributed to several factors. Firstly, fossil fuels are a significant input cost across various industries. Price hikes translate into businesses raising their own prices to maintain margins, ultimately impacting consumer goods and services. Secondly, fossil fuels are a cornerstone of electricity generation. Price increases in this sector directly translate to higher electricity costs for businesses and consumers alike. Furthermore, global supply and demand dynamics play a role. Reduced investments in new oil and gas production have limited supply, while consistent demand growth, particularly in developing economies, exerts upward pressure on prices with this the recent war in Ukraine, Russia being major producer of oil and gas, has further disrupted global supplies and exacerbated price increases[68][69]. The ultimate impact of rising fossil fuel prices on inflation varies by country, with economies heavily reliant on fossil fuels experiencing a more pronounced effect.

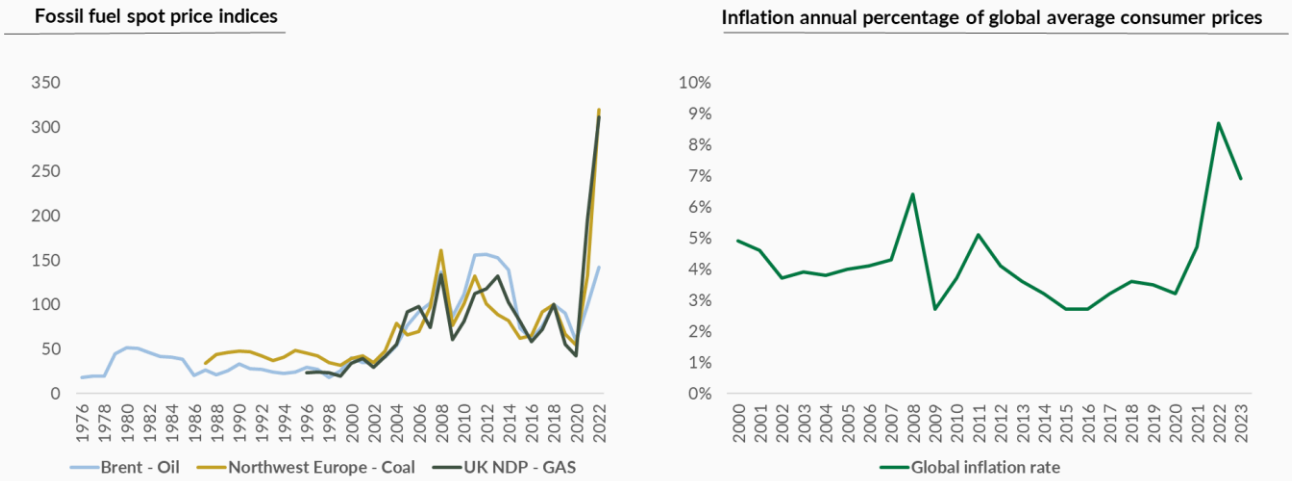


Figure 14: Fossil fuel spot price and global inflation[70] [71]

Renewable Energy in the Global Context

There has been a significant decline in the Levelized Cost of Energy (LCOE)[72] for renewable energy sources between 2010 and 2022 (Figure 15). Solar PV decreased from $0.45 per kWh to $0.05 per kWh during this period[73]. This trend can be attributed to several factors such as technological advancements which have played a key role, with innovations like thin-film solar cells (cheaper and lighter than traditional models) and solar tracking systems (maximizing sunlight capture) reducing costs. Additionally, increased production driven by rising demand has allowed manufacturers to benefit from economies of scale, further driving down prices[74]. Furthermore, innovative financing models like leasing and Power Purchase Agreements (PPAs) have made solar

[66] Energy Institute based on S&P Global Platts – Statistical Review of World Energy (2023)
[67] World Economic Outlook – Inflation rate, average consumer prices (2023)
[68] Energy Institute based on S&P Global Platts – Statistical Review of World Energy (2023)
[69] World Economic Outlook – Inflation rate, average consumer prices (2023)

[70] Energy Institute based on S&P Global Platts - Statistical Review of World Energy (2023)
[71] World Economic Outlook - Inflation rate, average consumer prices (2023)
[72] Our World in Data (2023)
[73] Our World in Data (2023)
[74] 8MSolar (2023)

power more accessible for individuals and businesses. Government policies and incentives, including subsidies and tax credits in many countries, have significantly encouraged the adoption of renewable energy sources[75].

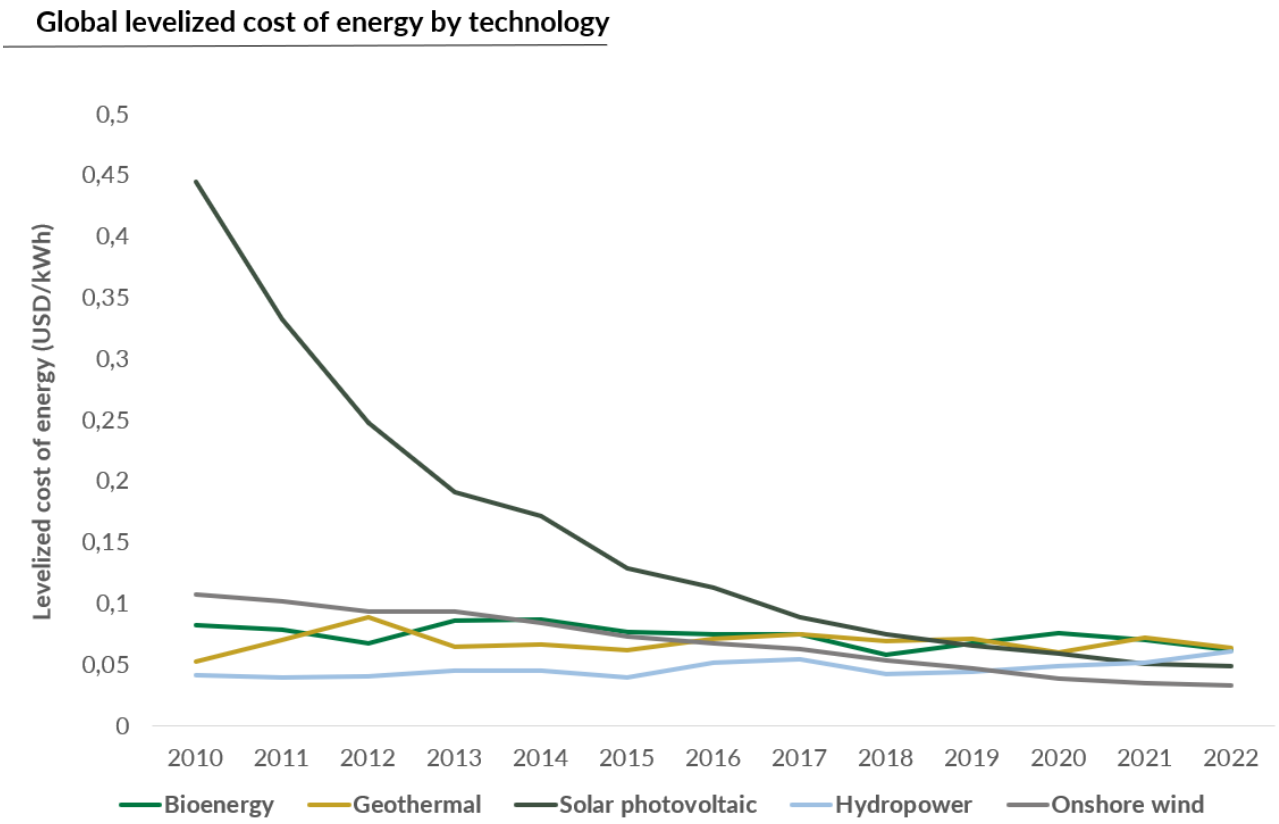


Figure 15: Levelized cost of energy for renewable energy technologies[76]

In terms of the global energy mix (Figure 16), fossil fuels have dominated for decades due to several factors, including their high energy density, dispatchable power, and established infrastructure. Oil, coal and natural gas were the dominant energy sources in 2021, contributing a combined total of 495 million TJ to global energy supply. Oil provided the most at 182 million TJ, followed by coal at 168 million TJ and natural gas at 145 million TJ[77].

Although fossil fuels currently dominate the global energy landscape, renewable energy sources are experiencing significant growth. Despite a slower overall increase compared to fossil fuels, renewables are showing promise. Biofuels and waste currently represent the largest renewable source, contributing 58 million TJ to the global energy supply in 2021[78]. Notably, wind and solar power have seen the most rapid growth in recent years, surpassing hydropower in the last five years suggesting that renewables have the potential to play a much larger role in the future global energy mix.

[75] 8MSolar (2023)
[76] Our World in Data (2023)
[77] International Energy Agency (2023)
[78] International Energy Agency (2023)

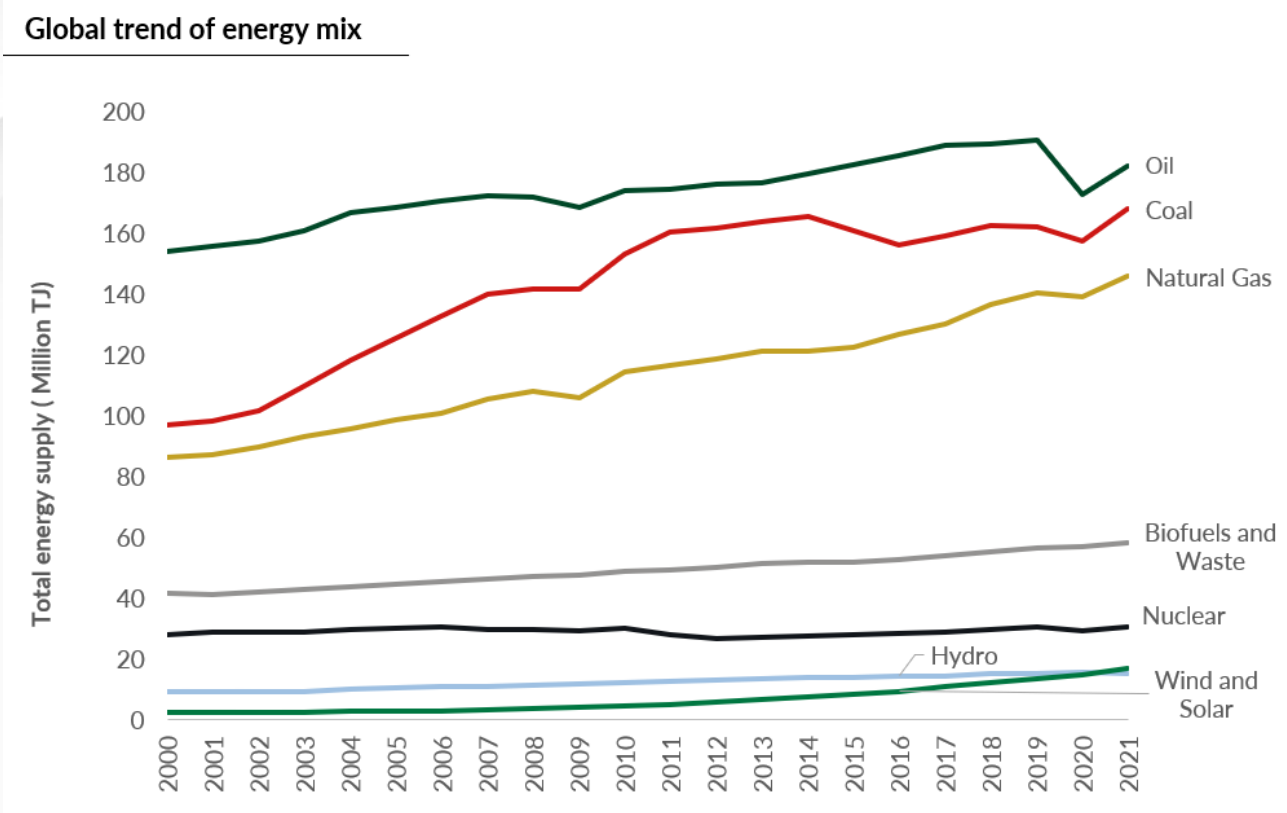


Figure 16: Global trend of energy mix between 2000 and 2021[79]

The global installed capacity of renewable energy sources from 2000 to 2022 has seen a significant increase (Figure 17). Hydropower has the highest installed capacity, reaching 1 392 GW in 2022, followed by solar power at 1 053 GW and wind power at 898 GW[80]. This growth is likely due to several factors, including technological advancements that have reduced the cost of renewable energy technologies, as well as government policies that have supported the development and deployment of renewables.

While hydropower has the highest installed capacity, its growth has slowed in recent years. This is likely due to several factors, including reduced rainfall in some regions, a decline in the number of suitable sites for new hydropower projects, and a shift in government policies towards solar and wind power[81]. In contrast, solar and wind power have seen significant growth in recent years. This is due in part to technological advancements that have made these technologies more efficient and affordable[82]. Additionally, government policies such as feed-in tariffs and tax credits have made it more attractive for businesses and individuals to invest in solar and wind power[83].

[79] International Energy Agency (2023)
[80] Our World in Data (2023)
[81] World Economic Forum (2023)
[82] International Renewable Energy Agency (2022)
[83] Environment America (2023)

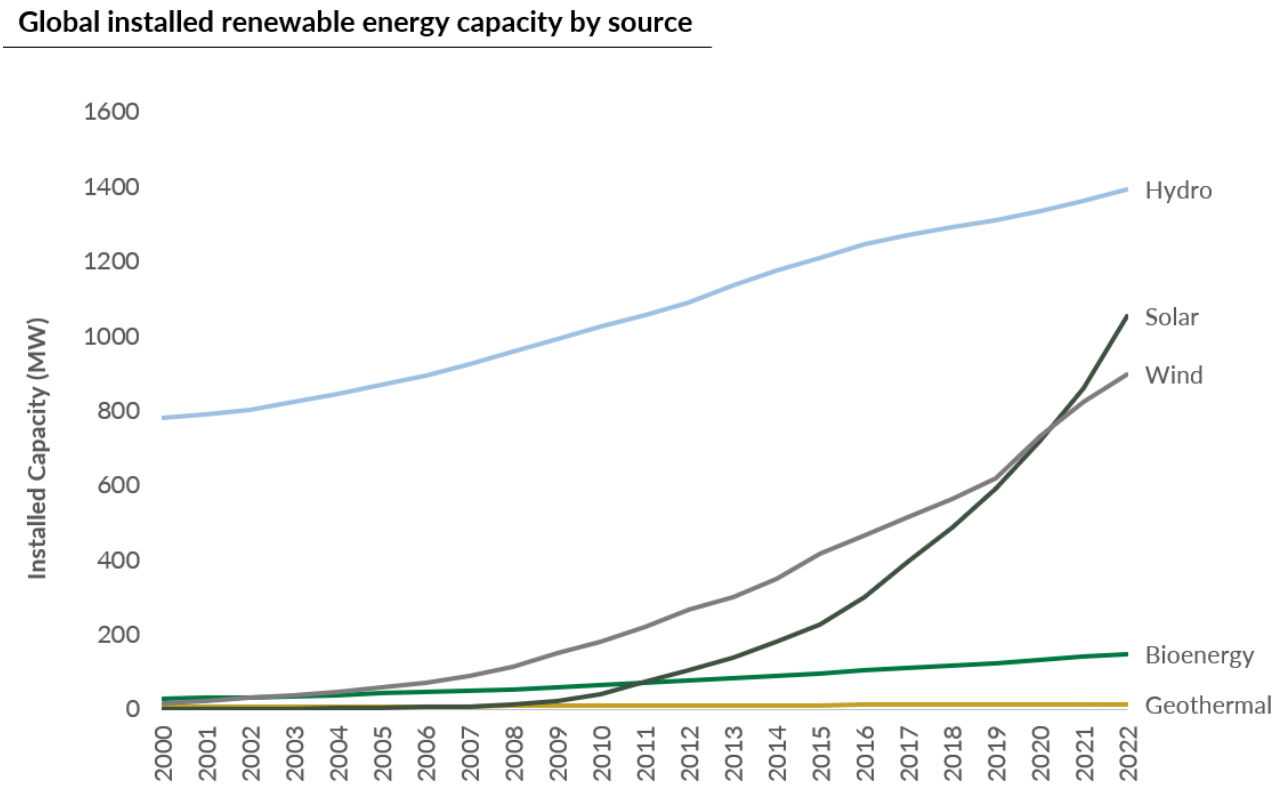


Figure 17: Global installed capacity of renewable energy by source[84]

This information is mirrored in the global electricity mix trend as the global electricity mix is undergoing a significant shift, with renewables and natural gas becoming increasingly dominant sources of power generation (Figure 18). This can be attributed to the cost of solar PV which has fallen by 80% between 2010 and 2019, while onshore wind power has seen a 60% decrease[85]. This dramatic cost reduction has made renewables a more economically attractive option for electricity generation.

Natural gas is also playing a growing role in the global electricity mix. In the United States, for example, natural gas supplied more than half of the country's electricity demand in 2023. This can be attributed to several factors, including a significant drop in the price of natural gas, the retirement of coal-fired power plants, and low output from wind and hydropower in that year[86].

While natural gas is a cleaner burning fossil fuel than coal, it still emits greenhouse gases. Therefore, the long-term trend in the electricity mix is expected to favour continued growth in renewables to reduce carbon emissions and mitigate climate change. In essence, renewables have a lower share in electricity mix compared to the total energy mix due to difficulties in decarbonizing certain sectors such as transportation, which are largely reliant on oil and gas.

[84] Our World in Data (2023)
[85] Energy Institute (2023)
[86] Enel (2023)

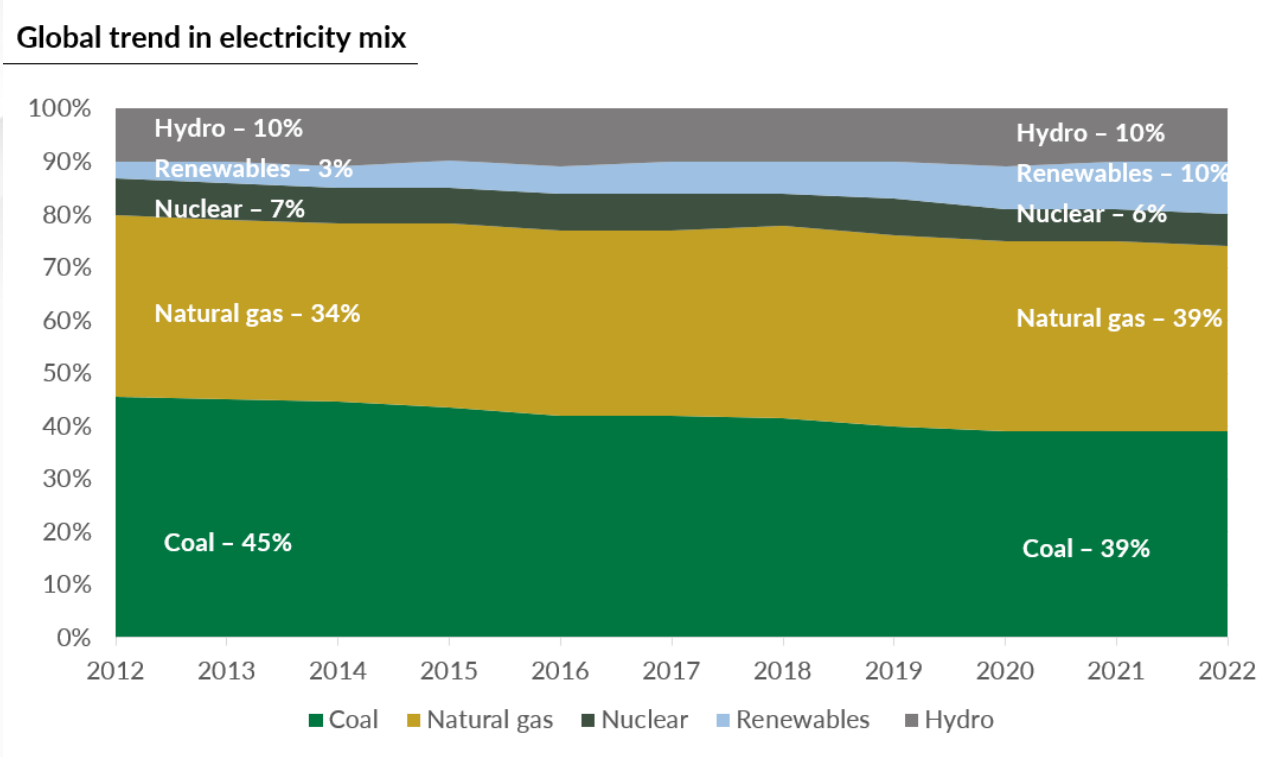


***Figure 18: Global trend in electricity mix*[87]**

In terms of renewable electricity generation globally (Figure 19), hydropower is the leading source, producing approximately 4 334 TWh in 2022 followed by wind and solar power at 2 104 TWh and 1 322 TWh, respectively. Some countries, like Norway, Uganda, and Lesotho, have a particularly high share of electricity generation from hydropower[8889]. However, it's important to note that for example, Norway's total electricity production is relatively low at 146 TWh (2022) due to its small population[90].

Beyond hydropower, the rapid growth of solar power is particularly noteworthy. This technology is increasingly finding its place in remote regions where limitations of traditional power grids come into play. The high cost of extending long-distance transmission lines often hinders electrification efforts in these areas. Solar power, with its decentralized nature and ability to function off-grid, offers a viable solution, bringing clean energy to previously underserved communities, as with the case for Australia.

[87] Energy Institute (2023)
[88] International Energy Agency (2022)
[89] Energypedia (2023)
[90] Business Norway (2023)

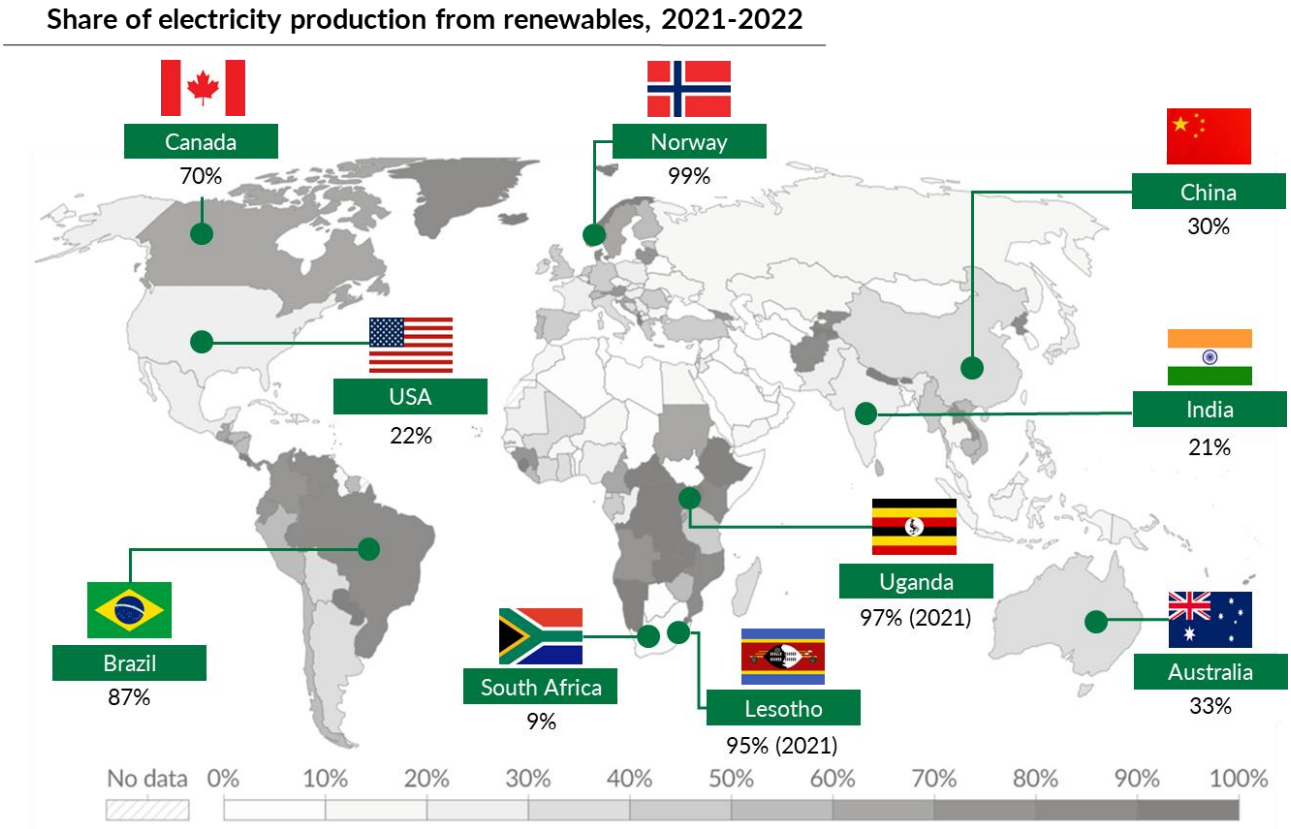


***Figure 19: Share of electricity production from renewable*[91]**

Table 3 highlights several countries that are utilizing community financing models to support the installation of renewable energy technologies. These nations include Australia, India, Italy, Japan, and the United States. This approach can offer several advantages, such as spreading the upfront costs, generating local revenue through electricity production, and fostering a sense of community ownership in the transition to clean energy[92].

In Africa, countries are at various stages of developing their renewable energy sectors (Table 3). Some nations, like Botswana with its sole 1 MW solar project in Tobela village, are taking initial steps with government-led solar initiatives. Others, like Egypt, which generates 90% of its electricity from fossil fuels despite significant solar and wind potential, are grappling with transitioning away from established systems[93].

In Kenya there has been significant investments in geothermal energy, with the Okana Geothermal Complex contributing substantially to its renewable energy capacity and M-KOPA Solar's pay-as-you-go model in Kenya providing clean energy to off-grid households. While boasting a staggering 2.5% potential of its vast river's hydro capacity, the Democratic Republic of Congo, faces challenges in harnessing this resource and expanding electricity access, which currently sits at only 15.5% with an aim to increase this figure to 32% by 2030.

Ghana presents a promising model with a diversified energy mix focusing on hydropower and solar. The Akosombo Dam on the Volta River serves as a major hydropower facility, while Independent Power Producers (IPPs) play a crucial role in expanding Ghana's renewable energy capacity, contributing not only to the energy sector but also to the nation's economic growth.[94]

[91] International Energy Agency (2022)
[92] Global Spotlight Report #37: Renewable Energy Best Practice - Climate Scorecard
[93] Global Spotlight Report #37: Renewable Energy Best Practice - Climate Scorecard
[94] Global Spotlight Report #37: Renewable Energy Best Practice - Climate Scorecard

Table 3: Renewable energy developments globally

Region	Country	Renewable energy developments
Global	Australia	• Through the Asian Renewable Energy Hub – it has installed 26 GW wind and solar generating capacity - which has a projected daily utilization rate of more than 70%
	India	• The State of Gujarat SKY Project has enabled 12 400 farmers in 33 districts of the state to generate solar power and use part of that power for irrigation, whilst simultaneously selling the surplus to the grid
	Italy	• The Energia Agricola project, is developing a sustainable model of energy transition based on solar PV and blockchain technologies
	Indonesia	• Through the Sindrap Wind Farm, impact mitigation practices are being used to minimise the damage to local environment from the construction of wind power stations
	United States	• The US industry added 32.4 GW on new electricity generating capacity in 2023 on the back of the Inflation Reduction Act • The US Inflation Reduction Act has the objective to reduce domestic inflation brought about by the energy crisis while also considering climate change issues
	Japan	• It is compulsory for power companies to purchase electricity generated by certified power generating renewable sources at fixed prices set by the government (Feed-In Tariff Scheme)
Africa	Botswana	• Government issues requests for solar PV project developers • Working with the World Bank to develop national renewable energy strategy • 1MW solar operation in Tobela village is the only operational renewable project
	Egypt	• 90% of Egypt's electricity from natural gas and oil (with significant potential for solar and wind energy) • Renewable energy has been encouraged through market liberalisation • Aims for 20% of electricity to be from renewable sources by 2023 • Plan to phase out energy subsidies to encourage renewable energy development
	Nigeria	• Through its 'Energy for All' initiative, aims to provide solar panels to 5 million household that are not currently on the grid

	Kenya	• Big investments made in geothermal energy • Kenya's biggest geothermal plant, Okana Geothermal Complex (contributed to renewable energy capacity) • M-KOPA Solar – provided pay-as-you-go solar home systems to increase access to electricity in rural areas
	Democratic Republic of Congo	• Supply primarily from hydroelectric power • State utility SNEL owning 94% of capacity • 2.5% of Congo's River's hydro potential • 15.5% access to electricity • Govt aims to increase electrification to 32% by 2030
	Ghana	• Diversified energy mix focusing on hydropower and solar) • Akosombo Dam on Volta River – major hydropower facility • IPPs play big role in expanding Ghana's renewable energy capacity –contributing to energy sector and economic growth in Ghana

The global energy landscape is undergoing a significant transformation, driven by a confluence of factors (Table 4). Climate change concerns are a key driver, with governments around the world increasingly turning to renewables to meet their carbon reduction pledges under the Paris Agreement and achieve Sustainable Development Goal 7 (affordable and clean energy)[95]. In addition, the recent energy crisis, characterized by rising fossil fuel prices due to factors like the war in Ukraine, has further emphasized the need for alternative energy sources leading to increased utilization of renewables[96].

Technological advancements are also playing a crucial role. Improvements in battery storage, such as more affordable and scalable lithium-ion batteries and long-lasting flow batteries, are making renewables more reliable and grid-integrable. Additionally, the electrification of key sectors like transportation, with electric car sales surging from 4% in 2020 to 14% in 2023, is creating a larger demand for clean energy[97]. This trend is expected to continue as countries implement stricter emission policies.

Investment in renewables is also experiencing a boom, with global investment reaching a record $358 billion in the first half of 2023, a 22% increase year-on-year with solar power attracting nearly two-thirds of this investment. China and the United States are at the forefront of this investment surge[98]. Additionally, policy adoption is playing a key role, with around 80 new renewable energy policies announced in 49 countries, primarily focused on financial incentives and regulatory frameworks[99]. Though Africa currently lags in policy adoption, the global trend suggests its role is likely to grow in the future.

[95] United Nations Climate Action (2023)
[96] Global Energy Crisis – Topics – IEA
[97] Ren21 - Renewable Energy in Demand
[98] Bloomberg New Energy Finance (2024)
[99] Climate Foresight (2024)

Table: 4 Areas impacting renewable energy [100] [101] [102] [103]

Key areas	Description
Climate change	• Environmental changes and concerns are driving the accelerated adoption of renewables with governments across the globe pledging to carbon reduction measures such as Net Zero driven by the Paris Agreement on Climate Change and Sustainable Development Goals (Goal 7 - ensure access to affordable, reliable, sustainable and modern energy for all)
Energy crisis and inflation	• Currently the global energy crisis involves all fossil fuels • Halting of output in some European gas-intensive manufacturing plants has worsen supply numbers while in China has had some of its supply cut-off • The Russian-Ukraine war contributed to European and Asia gas prices to skyrocket further • This has necessitated in the increased use of alternative sources of energy such as renewables
Technology improvements	• Batteries used for energy storage have evolved overtime supporting the adoption of renewables • Lithium-ion batteries: Becoming more affordable and scalable, making them attractive for grid-scale and residential applications • Flow batteries: Long cycle life, low degradation, high efficiency, and flexibility
Electrification of key sectors	• Electric car sales share of total sales has more than tripled in three years from 4% in 2020 to 14% in 2023 • If Stated Policies Scenarios (STEPS) and Net Zero Emissions (NZE) implemented by 2030, share of electric sales as percentage of total sales could rise to 25% and 60% respectively • New Zealand banned the installation of new low and medium temperature coal boilers in 2021
Increased investment	• Globally, new investment in renewable energy skyrocketed to $358 billion in the first six months of 2023, a 22% rise compared to the start of 2022 • Solar was the key driver with $239 billion invested in large - and small-scale systems • China accounted for approximately half of the investment in solar, followed by the United States - $25.5 billion
Policy adoption	• Around 80 new renewable energy policies, mostly in the form of fiscal/financial incentives, have been announced with 454 regulatory policies announced • These announcements were made in 49 countries, with only 4 in Africa

[100] United Nations Climate Action (2023)
[101] Global Energy Crisis – Topics – IEA
[102] Ren21 - Renewable Energy in Demand
[103] Bloomberg New Energy Finance (2024)

Energy Intensity

The Energy Intensity (EI) indicator, which tracks the amount of energy needed per unit of economic output (GDP), shows a positive trend. Globally, EI has decreased by 35% over the past two decades, driven primarily by improvements in energy efficiency (Figure 20). This includes advancements in operational practices and investments in energy-saving technologies.

Developed economies, particularly those within the OECD, have led the way in decoupling their economies from energy-intensive industries. These countries have transitioned towards service-based economies, resulting in significant reductions in EI. BRICS nations have also experienced a substantial decrease (52%), with China leading the charge through a remarkable 72% reduction in its EI over the same period.

However, developing countries currently lag behind due to the prevalence of energy-intensive industries like those focused on commodity exports. Additionally, low energy costs often create less incentive for investments in energy efficiency within these economies.

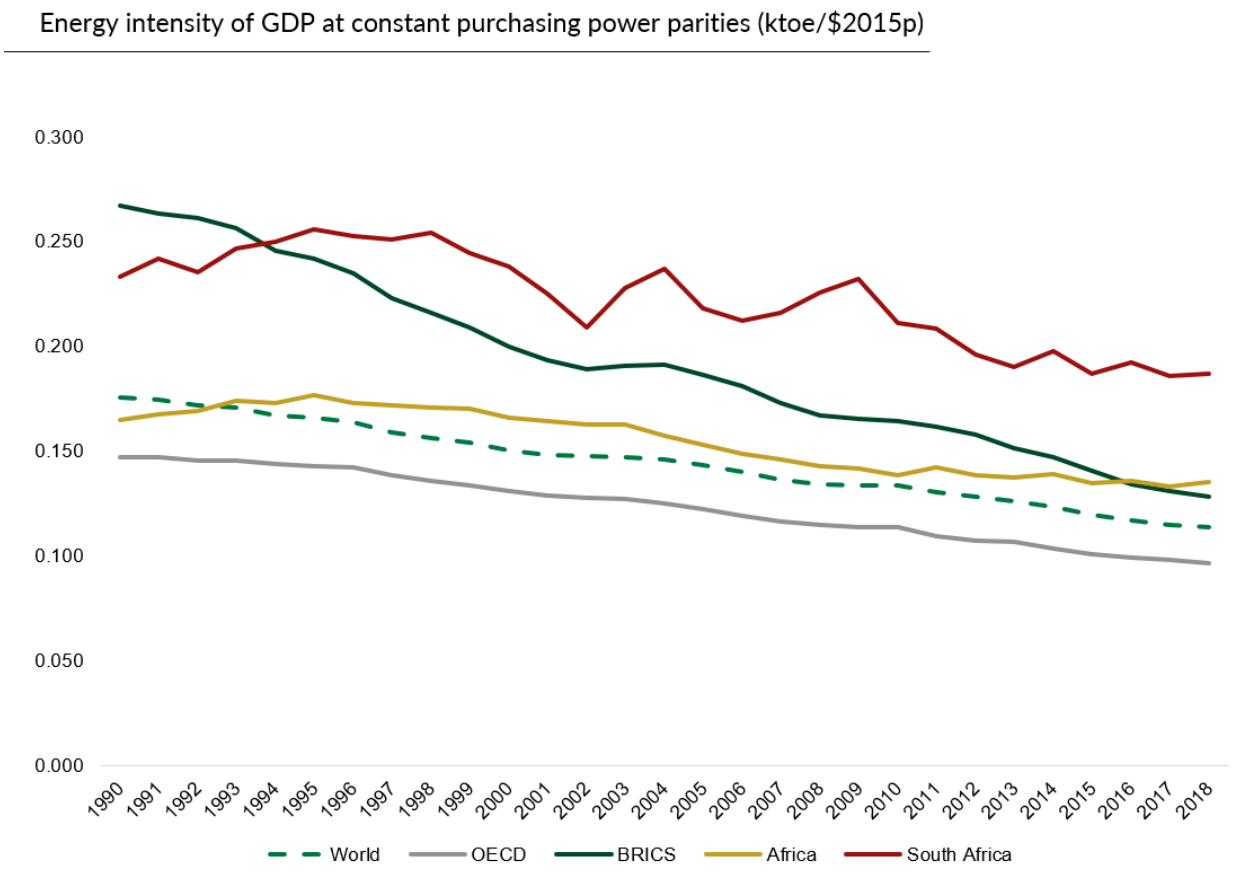


Figure 20 Energy intensity

3.4.2 Regional and South African Context

Regional Context

Despite contributing the least to global climate change, with an average of only 1 ton of CO_2 emissions per capita annually[104] (Figure 21), Africa is disproportionately vulnerable to its effects. This disparity is driven by socioeconomic factors that limit the continent's capacity to adapt.

Widespread poverty casts a long shadow, with nearly half of sub-Saharan Africa's population living below the international poverty line. This translates to limited access to resources and infrastructure, hindering the continent's ability to adapt to a changing climate. Food insecurity is another pressing concern, with over 250 million Africans estimated to be undernourished[105]. Furthermore, Africa contends with some of the world's highest disease burdens, particularly among children. Malaria, diarrheal diseases, lower respiratory tract infections, and HIV/AIDS pose significant public health threats[106].

These existing vulnerabilities paint a concerning picture for Africa's future as climate change tightens its grip. Studies suggest a grim scenario for East and Southern Africa, with droughts potentially lasting up to nine months by 2080[107]. Such prolonged dry spells would severely disrupt agricultural production, further exacerbating food insecurity. Climate projections also point towards a reduction in crop yields by up to 15% by 2050 due to factors like heat stress, drought, and flooding[108]. This decline, coupled with a growing population, raises the specter of widespread food shortages and malnutrition. The impact on health is equally worrying, with rising temperatures and changing weather patterns likely to increase the spread of vector-borne diseases like malaria, dengue fever, and yellow fever, further straining already fragile healthcare systems[105].

[104] Global Carbon Budget (2022)
[105] World Bank (2024)
[106] Food and Agriculture Organization of the United States (2024)
[107] World Bank (2024)
[108] Food and Agriculture Organization of the United States (2024)

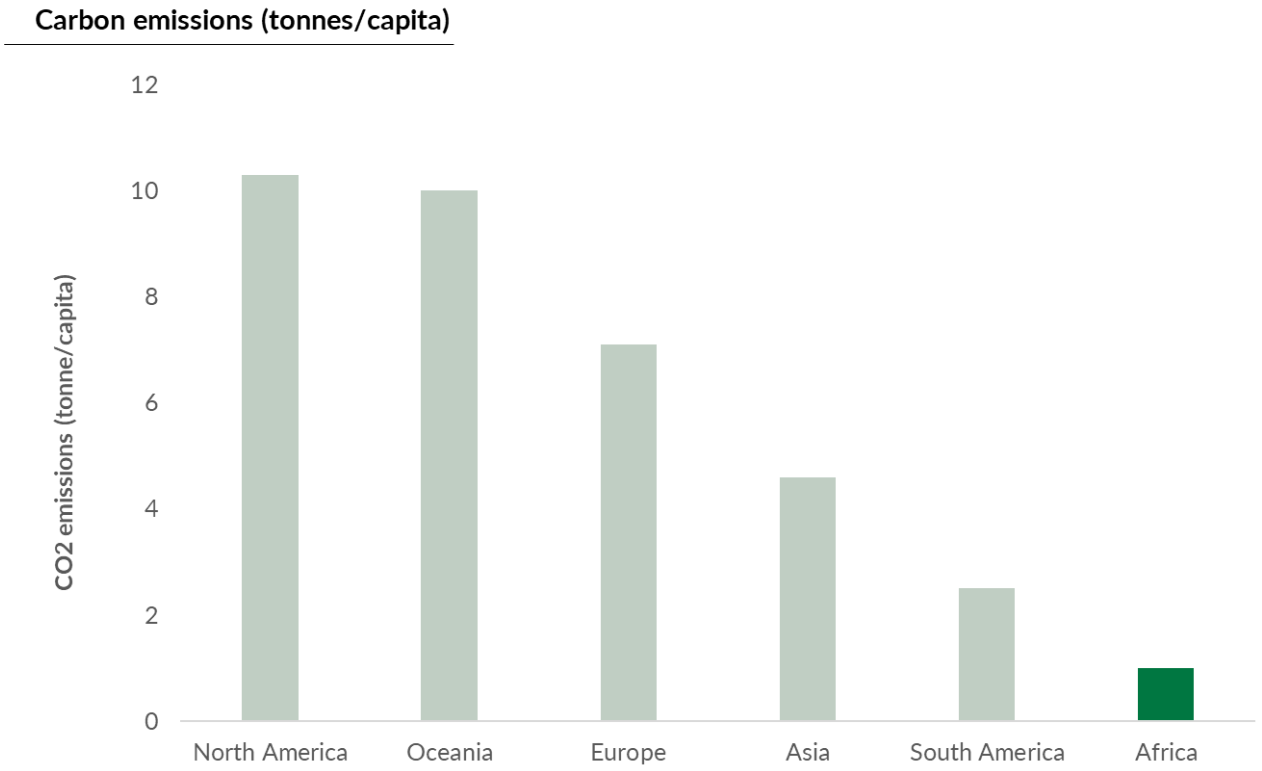


Figure 21: Carbon emissions across continents[109]

However, there are several plans and policies in place across Africa to tackle issues related to carbon emissions and global warming but require large investments (Figure 22). The African Union's Agenda 2063, a blueprint for the continent's transformation, incorporates a Climate Change and Resilient Development Strategy and Action Plan (2022-2032) that prioritizes crucial measures like fostering renewable energy sources, securing climate finance, and fortifying adaptation strategies to safeguard against the escalating impacts of climate change[110].

The financial constraints faced by many African nations are undeniable with countries like Ethiopia, Guinea, Rwanda requiring investing 16%, 14.5% and 9.1% of their GDP, respectively, towards addressing the SDGs for universal access to electricity[111] (Figure 20). A recent study by the Climate Policy Initiative and the Global Centre for Adaptation reveals that Africa received an average of $29.5 billion annually in climate finance during 2019 and 2020[112]. While this sounds substantial, only $11.4 billion, or 39%, was allocated towards adaptation efforts – crucial for enhancing resilience to climate change impacts.

The analysis further emphasized the vast discrepancy between current funding and future needs. Nationally Determined Contributions (NDCs) submitted by African countries indicate that adaptation needs for the continent will reach nearly $580 billion between 2020 and 2030[113]. This translates to a staggering funding gap of $453 billion over the next decade unless significant increases in adaptation finance materialize[114]. This situation underscores the urgent need for a robust financial response to climate change in Africa. Exploring

[109] Global Carbon Budget (2022)
[110] United Nations (2022)
[111] Oxford Economics (2018)
[112] Oxford Economics (2018)
[113] Climate Adaptation Finance in Africa (2023)
[114] Climate Adaptation Finance in Africa (2023)

innovative financing mechanisms, securing greater international support, and prioritizing resource mobilization within African nations are all crucial steps towards bridging this gap.

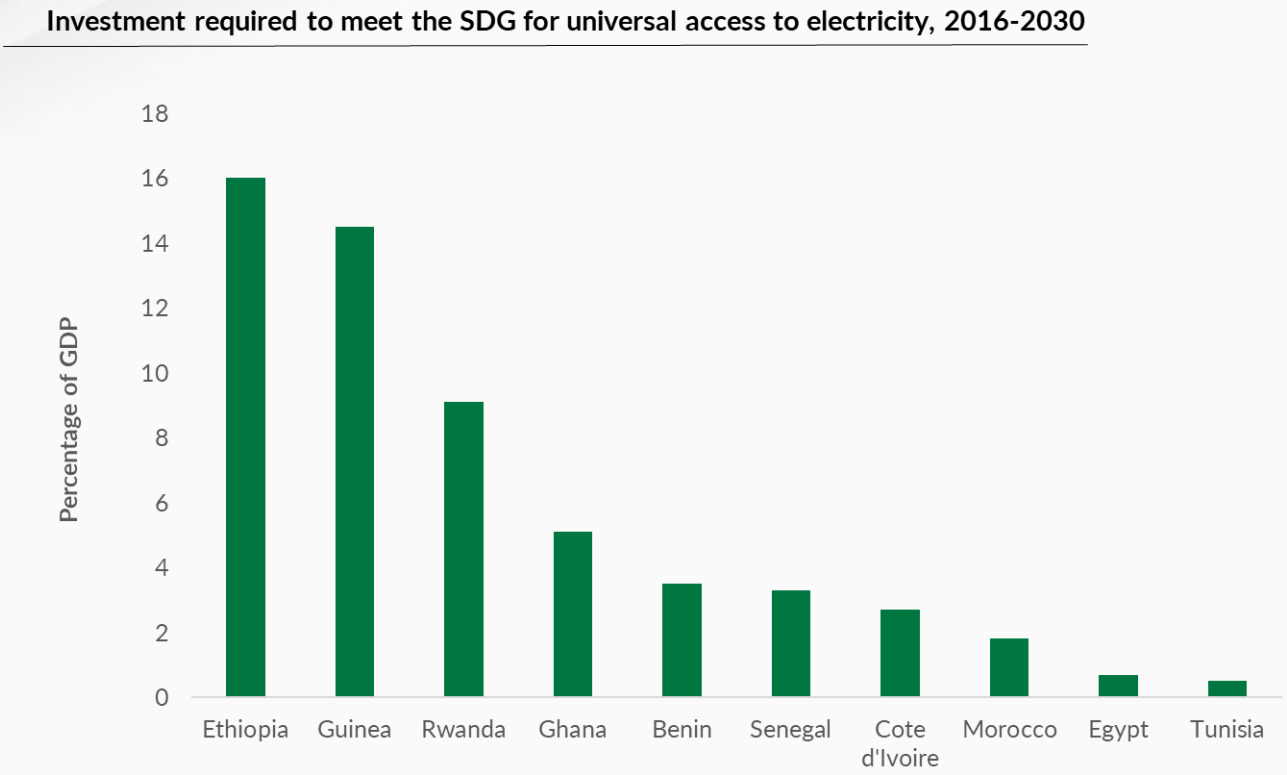


Figure 22: Investment required to meet SDG on electricity access[115]

Several Southern African Development Community (SADC) countries and islands have a strong dependence on traditional, carbon-intensive energy sources for electricity generation (Figure 23). For example, Botswana, with vast coal reserves estimated at around 200 billion tons, utilizes coal for 96% of its electricity generation[116]. Oil provides a minor supplementary role, contributing only 3.8% to the mix[117]. This heavy reliance on coal, a significant emitter of greenhouse gases and air pollutants, raises concerns about environmental impacts.

Similarly, island nations like Seychelles (88%) and Mauritius (78%) find themselves geographically disadvantaged when it comes to accessing alternative energy sources making them largely dependent on imported fossil fuels, primarily oil, to meet their electricity demands[118]. This dependence likely translates to higher energy costs and vulnerability to price fluctuations in the global oil market.

While Madagascar presents a somewhat more balanced picture, with oil (49%) and hydropower (30%) as its leading sources of electricity, a substantial portion of its energy mix still stems from fossil fuels[117]. This reliance on traditional sources may limit the country's ability to mitigate climate change and pursue a more sustainable energy future. It's important to note that South Africa, a major player in the African energy sector is known to be the highest contributor of CO_2 (392 $MtCO_2$) emissions among SADC countries, and its energy mix reflects

[115] Oxford Economics (2018)
[116] The United States Agency for International Development (2021)
[117] International Energy Agency (2021)
[118] International Energy Agency (2021)

this (~90% fossil fuel)[119]. This is staggering compared to CO_2 contributions from Botswana (4 $MtCO_2$), Mauritius (4 $MtCO_2$) and Madagascar (4 $MtCO_2$) Figure 23.

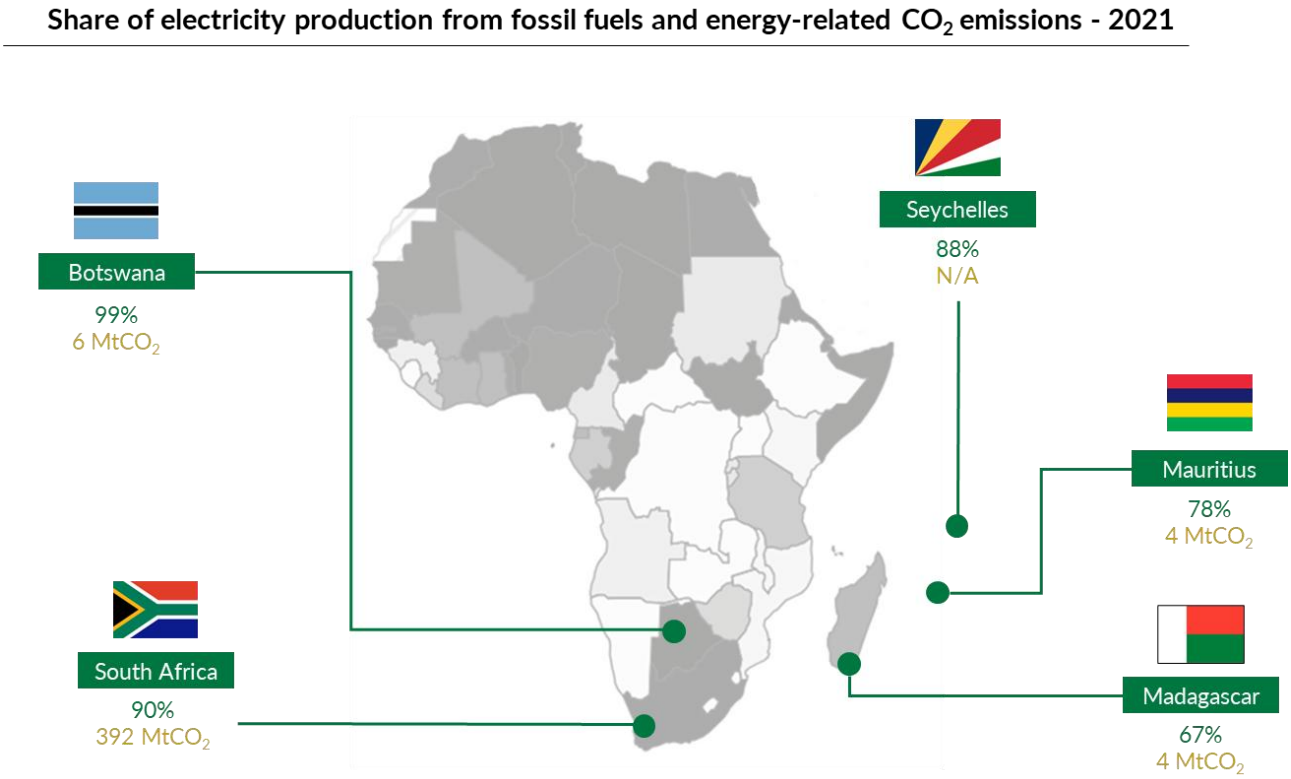


Figure 23: Share of electricity production from fossil fuels and CO2 emissions[120]

South African Context

South Africa faces a critical challenge in transitioning away from its coal-dependent electricity generation to meet climate change mitigation goals. A key factor influencing the pace of this transition is the ability to develop sufficient replacement capacity with renewable energy sources and battery storage. Financial and logistical support, along with skilled labour and regulatory frameworks, are all crucial aspects for enabling this transition.

The recent Conference of the Parties COP27 provided some promising avenues for South Africa. The establishment of a fund to support developing nations in addressing climate change impacts offers a potential source of funding for South Africa's own mitigation and adaptation efforts. Furthermore, the $8.5 billion Just Energy Transition Partnership announced at COP26, followed by the detailed JET Investment Plan (JET-IP), presents a concrete plan for international support directed at facilitating South Africa's shift towards cleaner energy sources[121].

For Eskom, the national power utility, a significant portion (70%) of the JET-IP funds is earmarked for commissioning renewable energy projects, grid upgrades, and improvements to municipal distribution systems. This allocation aligns directly with South Africa's planned decommissioning of coal-fired power stations by

[119] International Energy Agency (2021)
[120] International Energy Agency (2021)
[121] South Africa's energy transition and growth path to Net Zero

2034. By prioritizing renewable energy and investing in infrastructure improvements, Eskom can play a pivotal role in achieving a smoother and more sustainable energy transition.

However, uncertainties remain regarding the specific disbursement mechanisms for the JET-IP funds. It is unclear whether the funds will be allocated to specific projects, or whether Eskom will receive a direct portion. Securing a dedicated allocation for Eskom would be instrumental in facilitating the company's transmission and distribution development plans, as well as supporting ongoing repurposing and repowering initiatives for existing power stations.

In response to the Paris Agreement's call for emissions reductions, South Africa has established its own Nationally Determined Contribution targeting a pathway that limits global temperature increase to 1.5°C above pre-industrial levels (Figure 24). This translates to a specific target range for carbon emissions by 2025 (398–510Mt CO_2) and 2030 (350–420Mt CO_2), following a "peak, plateau and decline" trajectory towards net zero emissions by 2050[122]. South Africa's commitment to net zero emissions by 2050 also emphasizes the importance of job creation alongside environmental goals within the framework of the Just Energy Transition strategy.

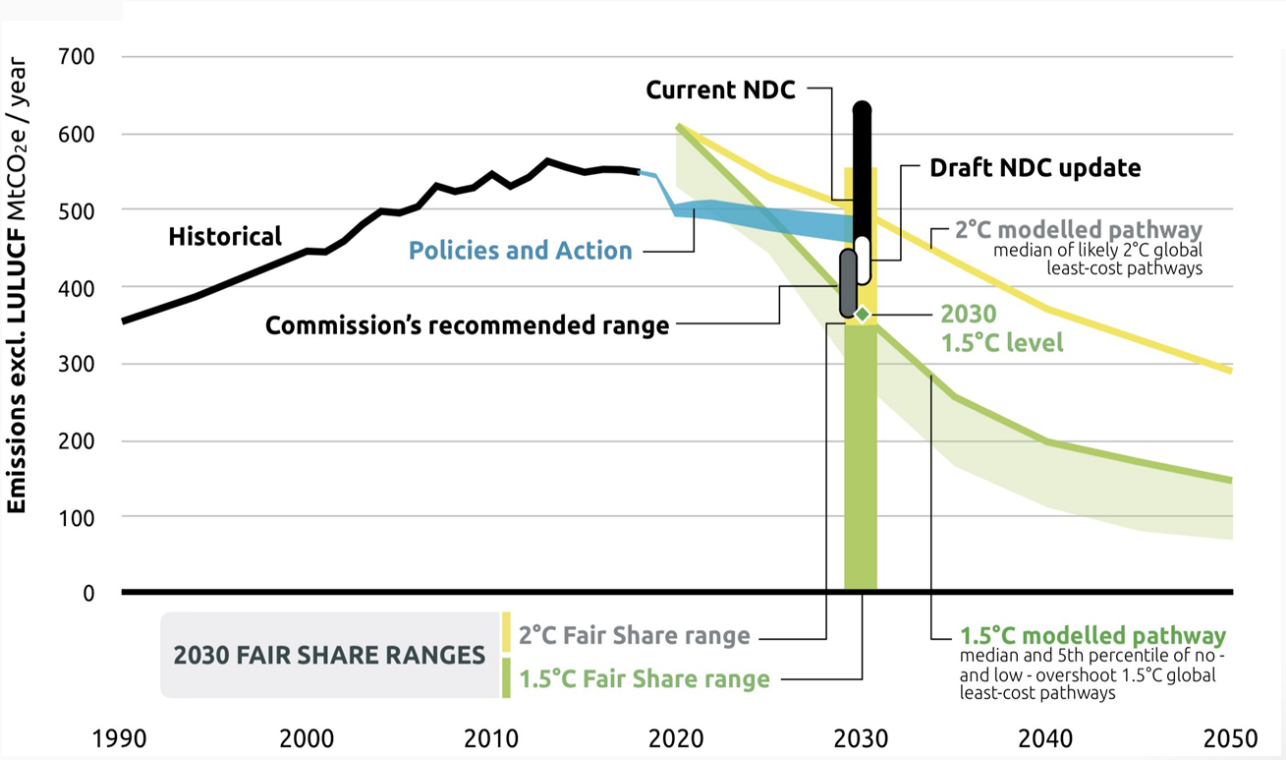


Figure 24: South Africa Modelled Pathways to Achieve Net Zero[122]

The Energy Availability Factor (EAF) of coal-fired power stations is a metric used in the power industry to measure the percentage of time a power plant is available to generate electricity. In terms of ESKOMs coal-fired power stations, the EAF has been declining over time from around 90% in 2008 to 58% in 2023[123] (Figure 25). This can be attributed to several factors such as ageing infrastructure, maintenance and decommissioning of 11 coal-power stations.

For Eskom, a significant portion (70%) of the Just Energy Transition Investment Plan (JET-IP) funds is earmarked for commissioning renewable energy projects, grid upgrades, and improvements to municipal distribution

[122] South Africa's energy transition and growth path to Net Zero
[123] Eskom Energy Availability Factor; PCLF- Planned outages; UCLF – Unplanned outages; MTSAO, 2024-2028

systems. This allocation aligns directly with South Africa's planned decommissioning of coal-fired power stations by 2034. By prioritizing renewable energy and investing in infrastructure improvements, Eskom can play a pivotal role in achieving a smoother and more sustainable energy transition.

South Africa's transition from coal-based electricity generation to renewable energy sources is a complex challenge, balancing the need to reduce carbon emissions with the urgency to maintain a stable energy supply. The debate centers on whether to extend the lifespan of existing coal-fired power stations, like Grootvlei, Camden and Hendrina, beyond their planned 2027 closure (to 2030).

Proponents, including Electricity Minister Dr. Ramokgopa, argue that this extension is necessary to avoid an immediate energy shortage while renewable energy capacity and storage solutions are being developed. Opponents counter that focusing on renewable sources is crucial for long-term environmental sustainability and meeting climate goals. The pace of the transition depends on several factors, including financial and logistical support, skilled labor availability, and effective regulatory frameworks. This complex issue requires careful consideration of both immediate energy needs and long-term sustainability goals.

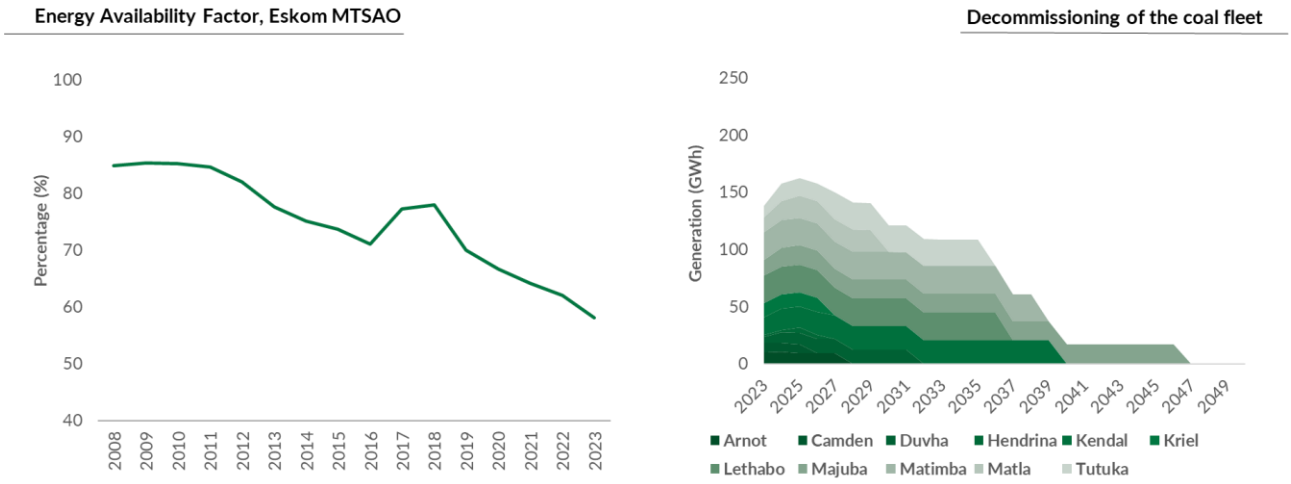


Figure 25: Eskom's energy availability factor and decommissioning of coal fleet[124]

This has contributed to the energy crisis in South Africa, resulting in loadshedding, significantly impacting both households and businesses (Figure 26). For households, the primary disruption is the limitation of necessities. Load shedding restricts lighting during crucial hours, hindering productivity for students studying or those working late. Furthermore, limited access to electricity impacts daily routines like cooking and heating homes during cold weather. This leaves households with two choices: endure these limitations due to a lack of resources or invest in alternative power sources like generators or solar panels which are generally associated with high cost[125].

[124] Eskom Energy Availability Factor; PCLF- Planned outages; UCLF – Unplanned outages; MTSAO, 2024-2028
[125] Statistics South Africa; Living Conditions Survey (Stats SA)

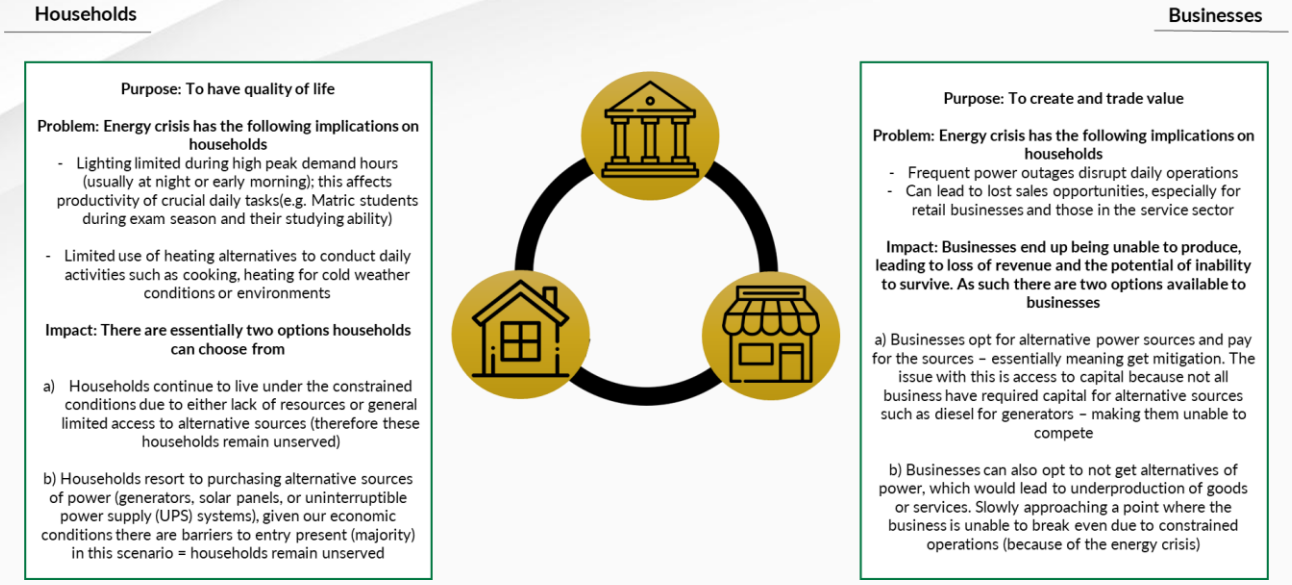


Figure 26: Impact of loadshedding on households and businesses[126]

Similarly, businesses aiming to create and trade value also face significant challenges. Frequent outages disrupt daily operations, leading to lost sales opportunities, especially in retail and service sectors. This ultimately translates to lost revenue and potential business closure. Businesses have similar options: invest in alternative power sources like generators, which require significant capital that many lack, putting them at a competitive disadvantage or operate under constrained conditions, leading to underproduction and ultimately the inability to break even[127]. This energy crisis creates a lose-lose situation for both households and businesses, highlighting the urgent need for a sustainable solution.

Currently Eskom's generation is approximately 83% from coal and nuclear power stations which has dropped from levels of 89% in 2021. On the other hand, renewables either through IPPs and Eskom's pumped storage are increasing their share of the power mix gradually over time. Renewable IPP unit costs have continued to decline as suppliers in the latter RE-IPP bid windows have lower contracted rates. With these new IPPs being connected to the grid, this has contributed to an increased higher proportion of renewable IPPs in generation.[128]

However, due to higher levels of load shedding Eskom grew its generation through Open Cycle Gas Turbines (OCGTs) by 65% from 2022 to 2023 mainly to support the power system. This has allowed generation through OCGTs to rise to 3 018 GWh which is more than double the generation seen in 2021. Together with generation through IPP OCGTs and Eskom OCGTs, the primary energy costs for Eskom grew by 16.6% largely driven by the OCGTs generation. All primary energy costs grew apart from generation through renewables which contracted by 2.02% to 1.99 R/kWh in 2023. However, generation through renewable IPPs remains less competitive compared to traditional sources such as coal and nuclear which are priced at 0.49 and 0.11 R/kWh respectively. In conclusion, more expensive power stations saw higher coal demand due to generation performance challenges, which in turn raised the unit cost of coal by 12.07% from 2022 to 2023 as per Figure 27 below.[129]

[126] Statistics South Africa; Living Conditions Survey (Stats SA)
[127] Statistics South Africa; Living Conditions Survey (Stats SA)
[128] Eskom Integrated Report (2023)
[129] Eskom Integrated Report (2023)

Eskom generation in GWh from different sources

Source	2021	2022	2023
Coal-fired stations	183,553	184,568	171,131
Independent power producers (IPPs)	13,526	15,973	17,957
Nuclear power	9,903	12,355	9,803
Imports	8,812	8,500	8,654
Hydro stations	1,387	1,943	3,060
Open-cycle gas turbines (OCGTs)	1,457	1,826	3,018
Wheeling	2,310	2,499	2,904
Wind	305	253	214

Eskom unit cost per generation category in Rand per KWh (R/KWh)

Source cost	2022	2023	Percentage Change
Coal	0.44	0.49	▲ +12.07%
Nuclear	0.10	0.11	▲ +7.07%
Eskom-owned OCGTs	4.74	7.08	▲ +49.21%
IPPs	2.20	2.33	▲ +5.54%
a. IPP OCGTs	4.57	7.28	▲ +59.12%
b. Renewable IPPs	2.03	1.99	▼ -2.02%
International purchases	0.63	0.75	▲ +19.68%
Average unit cost	**2.10**	**2.86**	-

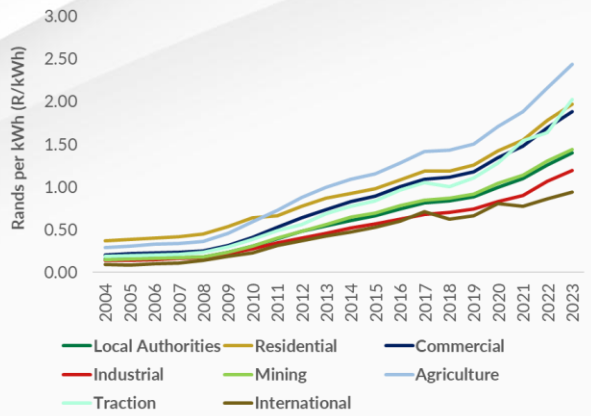
Figure 27: Eskom generation from different sources and Eskom unit cost per generation category[130]

Since 2004, there has been a steady increase in Eskom's tariffs across all sectors (Figure 28). In the last two years, NERSA has approved Eskom's tariff increase due to excessive use of OCGTs for power generation. NERSA has had to balance the difficult act of supporting sectoral development to achieve economic development and increase social equity through access to electricity while ensuring it approves Eskom tariffs to allow the power generator to cover its costs and earn a reasonable return.[131]

Regarding the sales volume per customer category, it shows that distributors are the biggest consumers of electricity (79 480), followed by Industry (44 635) and Mining (27 843), particularly in the last three years. It is important to note that the sales volume has decreased between 2021 and 2023 for all customer categories. This may be the result of supply constraints, which led to load-shedding and load curtailment, coupled with lower electricity demand from customers at times due to difficult economic conditions and the impact of increased embedded self-generation such as solar PV and wind[132]. However, although sales volume dropped by 5%, Eskom achieved revenue growth of 4.8% in 2023, indicating the transfer of increased cost from more expensive sources to the end consumer.

[130] Eskom Integrated Report (2023)
[131] Eskom Integrated Report (2023)
[132] Daily Investor (2023)

Average Eskom tariffs per demand sector



Electricity sales per customer category in GWh

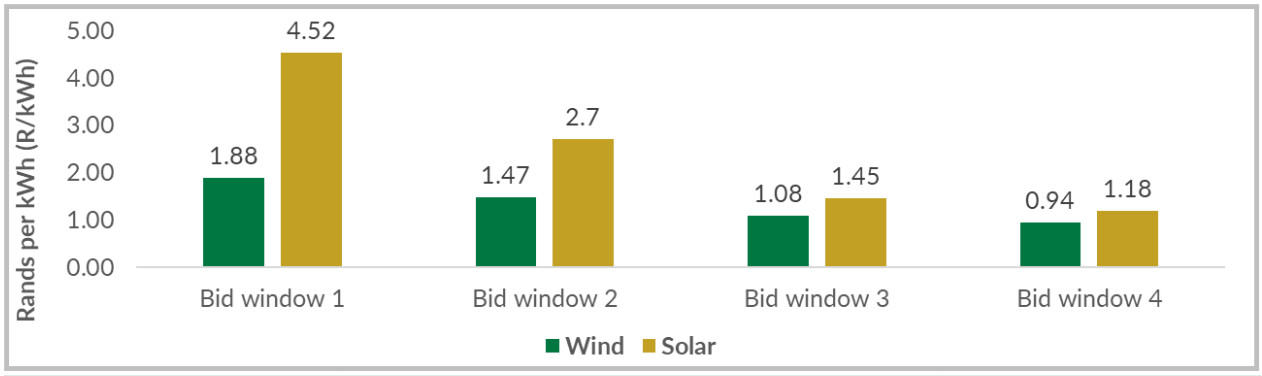
Bulk sales	2021	2022	2023
Distributors	82,354	83,831	79,480
Industrial	40,973	45,220	44,635
Mining	26,991	28,030	27,843
International	13,497	13,298	11,437
Commercial	9,696	9,872	9,376
Residential	10,949	10,520	9,177
Agricultural	5,461	5,382	4,785
Rail	1,931	2,128	1,668

Figure 28: Average Eskom tariffs and sales per demand sector[133]

As of 2023, the agriculture sector being an energy intensive sector, heavily reliant on electricity for irrigation and refrigeration, has the highest tariff (2.43 R/kWh) with the international sector the lowest tariff of 0.93 R/kWh[134] (Figure 29). This is since the agriculture sector often encompasses remote and sparely populated areas, increasing the cost of electricity supply due to the required infrastructure for distribution and maintenance[135]. Lower tariffs for international customers point towards strategic decisions to maintain competitiveness in the regional energy market. This reflects Eskom's commitment to the Southern African Power Pool (SAPP). Data on the average tariffs for renewables indicate dramatic cost reduction for wind and solar PV respectively since Bid window 1 in 2011. Wind decreased from 1.88 R/kWh to 0.94 R/kWh and solar from 4.52 R/kWh to 1.18 R/kWh between Bid window 1 and 4 from 2011 to 2015[136]. This indicated that renewables are becoming the most cost-effective option, but they're also crucial for addressing power shortages and reducing reliance on coal, highlighting the potential for job creation, economic growth, and a just energy transition through increased renewable energy deployment with storage and demand management as complementary solutions. All whilst Eskom's tariffs have been increasing (Figure 29).

[133] NERSA's decision regarding 2023-25 electricity tariffs
[134] NERSA's decision regarding 2023-25 electricity tariffs
[135] Eskom IDM Tariffs for Agriculture Sector
[136] Independent Power Producers Procurement Programme (2021)

Average tariffs and revenue per customer for renewables and Eskom respectively



Category (R/KWh)	2021	2022	2023
Agricultural	1.879	2.155	2.437
Rail	1.542	1.634	2.023
Residential	1.546	1.776	1.967
Commercial	1.475	1.694	1.879
Mining	1.138	1.307	1.435
Distributors	1.096	1.257	1.402
Industrial	0.904	1.066	1.193
International	0.769	0.861	0.935
Average	**1.368**	**1.556**	**1.762**

Figure 29: Average tariffs for renewables and Eskom[137]

South Africa introduced the Renewable Independent Power Producer Programme (REIPPPP) in 2011 which the aim to bring additional megawatts onto the country's electricity system through private sector investment in wind, biomass, and small hydro, among others. Over 6 000 MW, from a total of 89 projects of generation power has been awarded to bidders across various renewable technologies, with a strong focus on wind and solar energy. The program not only promotes clean energy production but also unlocks economic benefits. The Eastern Cape, for instance, has seen significant job creation (over 18 000) and a R33.7 billion investment through the establishment of 16 wind farms and one solar project. The province has even witnessed reduced loadshedding due to the additional energy security provided by the DEDISA peaking power station[138].

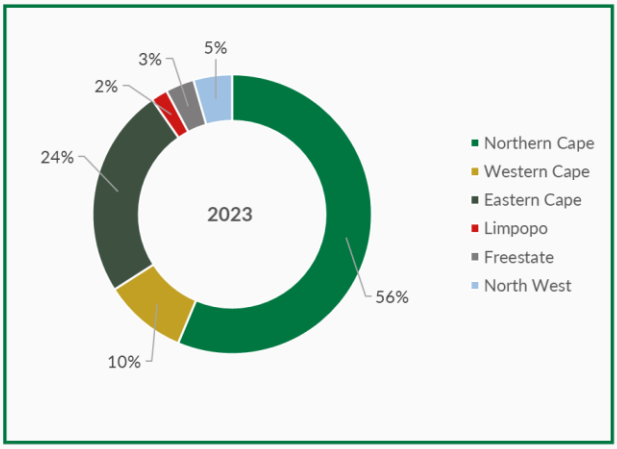
While renewables are a key focus, the REIPPPP also acknowledges the role of traditional sources to meet current demands. Around 2 500 MW has been allocated for coal procurement through IPPs. Additionally, South Africa is pursuing the Grand Inga Project, a collaboration with the Democratic Republic of Congo to secure a further 2 500 MW. A formal agreement established in 2014 lays the groundwork for this cross-border energy partnership[139].

[137] Independent Power Producers Procurement Programme (2021)
[138] Independent Power Producers Procurement Programme (2021)
[139] Independent Power Producers Procurement Programme (2021)

Figure 30 provides a geographical breakdown of renewable energy procurement in South Africa by Independent Power Producers (IPPs). The Northern Cape has the largest share (56%) of the total installed capacity, translating to 3 463 MW of renewable energy. This is followed by Eastern Cape at 24% (1 496 MW) and Western Cape with 10% (592 MW). The remaining provinces (North West, Free State and Limpopo) collectively contribute 10% (597 MW)[140].

At a more local level, Eskom estimates that the current rooftop solar PV installed capacity is 5 412 MW[141]. Further development of rooftop PV across residential, commercial, and government buildings could lead to a substantial increase in clean energy production within the national grid.

Provincial share of renewables installed capacity by IPPs



Installed capacity in MW

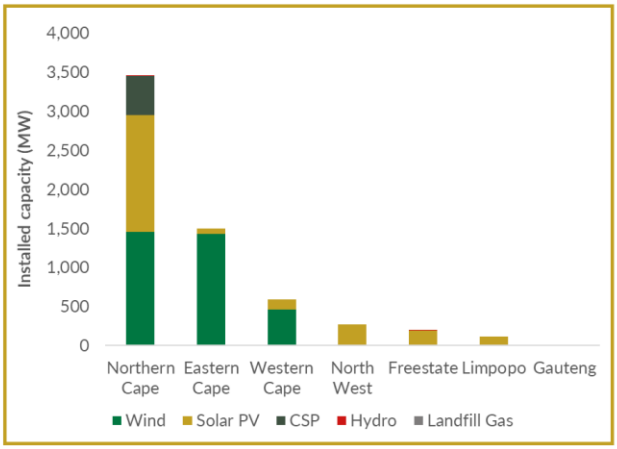
Province	Total Installed Capacity (MW)	Number of Operational IPPs
Northern Cape	3,463	47
Eastern Cape	1,496	17
Western Cape	592	11
North-West	275	5
Freestate	204	5
Limpopo	118	3
Gauteng	-	-
KZN	-	-
Mpumalanga	-	-

Figure 30: Share of renewable installed capacity from IPPs across the province[142]

Figure 31 indicates the distribution of renewable energy technologies across the various provinces. The data indicates that wind power dominates the renewable energy landscape, with a total installed capacity of 3 342 MW spread across Northern Cape (1 458 MW), Eastern Cape (1 426 MW) and Western Cape (458 MW). This is likely due to the region's strong and consistent wind resource[143].

[140] IPP Projects - Project Database
[141] Eskom Generation Adequacy Report – Medium Term
[142] IPP Projects - Project Database
[143] IPP Projects - Project Database

Renewables technologies mix per province



Installed capacity in MW

Province	Wind	Solar PV	CSP	Hydro	Landfill Gas
Northern Cape	1,458	1,495	500	10	-
Eastern Cape	1,426	70	-	-	-
Western Cape	458	134	-	-	-
North-West	-	275	-	-	-
Freestate	-	196	-	8	-
Limpopo	-	118	-	-	-
Gauteng	-	-	-	-	8
KZN	-	-	-	-	-
Mpumalanga	-	-	-	-	-

Figure 31: Renewable technology mix across provinces[144]

Solar PV comes in second, with a total installed capacity of 2 288 MW spread across all provinces except Gauteng, KwaZulu-Natal, and Mpumalanga. Norther Cape has the largest installed capacity for solar PV (1 495 MW). Other renewable energy sources, including Concentrated Solar PV (CSP), hydro, and landfill gas, have a significantly lower presence across all provinces as shown in Figure 32 above[145].

As per Eskom's Eskom Generation Connection Capacity Assessment (GCCA) 2025, there is a significant push towards diversifying South Africa's energy mix through the integration of IPPs. These producers play a pivotal role in the country's transition towards renewable energy, contributing to the national grid with solar photovoltaic, wind, dispatchable generation through OCGTs, and CSP. The GCCA 2025 indicates a substantial increase in IPP generation commitments, suggesting a shift in the energy landscape towards more sustainable and renewable sources. Several IPPs that have attained budget quotations and are earmarked to be connected to the Limpopo grid by 2025, with an additional capacity of 930 MW this has the potential to bring the Limpopo installed capacity to 1 048 MW[146].
The GCCA 2025 provides a detailed look at the available grid connection capacity for new power generation projects in South Africa, broken down by supply areas. Figure 32 outlines the remaining grid connection capacity as per each supply area with individual committed IPP generation noted in the following paragraphs[147]:

[144] IPP Projects - Project Database
[145] Eskom Generation Adequacy Report – Medium Term
[146] Eskom Generation Connection Capacity Assessment (GCCA) (2025)
[147] P Projects - Project Database

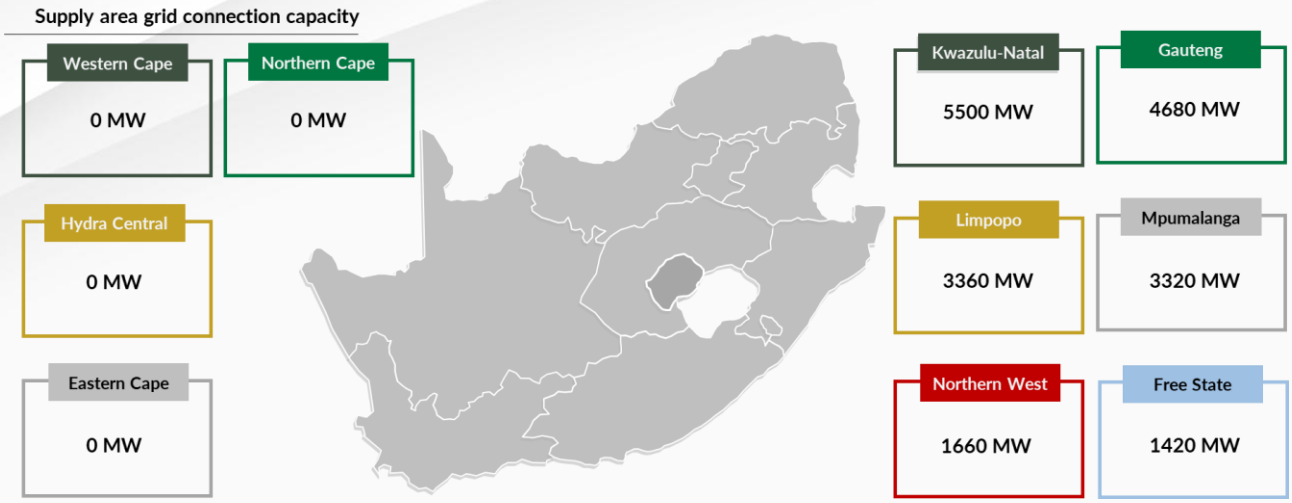


Figure 32: Grid connection capacity per supply area

- **Northern Cape:** This area has historically attracted significant interest from renewable energy developers, especially for solar PV and wind projects, due to its favourable environmental conditions. However, generation connection capacity in the Northern Cape has been fully utilized, with no additional capacity available for new projects by 2025. With the province encompassing a range of technologies across wind, PV, and CSP, it includes IPPs such as Aggeneys Solar, Sishen Solar Facility, and Copperton Wind Farm, collectively providing a capacity of over 2 000 MW. These projects are at various stages, with some operational and others, like Kathu Solar Energy Facility and Greefspan PV Power Plant, having achieved budget quotations status.

- **Western Cape:** Like the Northern Cape, the Western Cape has seen its generation connection capacity depleted by 2025. This region's high renewable energy potential, particularly for wind power, has led to rapid capacity uptake, leaving no room for new connections without significant network enhancements. The Western Cape is host to a mix of renewable energy projects, with wind and gas being notable technologies. Projects like FE Overberg and Darling Wind Power are pioneering wind energy initiatives, while Saldanha Powership represents a significant move towards integrating OCGT Gas technology under the RMIPPPP. The region is diversifying its energy portfolio through these projects, with several attaining budget quotations status, ready for grid connection, contributing to the renewable energy capacity in the area.

- **Eastern Cape:** The Eastern Cape is another area with depleted generation connection capacity by 2025, driven by its attractiveness for both wind and solar projects. The capacity limitations are attributed to the existing network's inability to accommodate additional generation without upgrades. A combination of wind and gas projects, such as Coega Powership and Jeffreys Bay Wind Farm, are pivotal in the region's energy development. These projects, including Oyster Bay Wind Farm, not only underscore the Eastern Cape's commitment to renewable energy but also its strategic importance in South Africa's broader energy landscape. The IPPs in this region, many of which have reached budget quotations status, are set to enhance the grid with renewable sources.

- **Hydra Central:** This supply area also faces a complete depletion of its generation connection capacity by 2025. The area's strategic position and potential for renewable energy generation have led to a saturation of its existing grid infrastructure. Featuring a mix of wind and PV projects like Coleskop Wind Power, De Aar Solar PV, and Longyuan Mulilo De Aar 2 North Wind Energy Facility, totalling a

potentially installed capacity of 2 509 MW by 2025. Projects like Noupoort Mainstream Wind and Mulilo De Aar 2 South Wind Energy Facility highlight the diversity of renewable sources.

- **KwaZulu-Natal:** In contrast to the depleted areas, KwaZulu-Natal shows available capacity for new connections, with an additional 5 500 MW projected to be available by 2025. This presents opportunities for renewable energy development in the region. KwaZulu Natal is focusing on Liquified Natural Gas (LNG) and wind projects, with Karpowership with a potential installed capacity of 450 MW leading the LNG initiative and Waaihoek representing the wind energy sector with a porntial installed capacity of 140 MW. These projects are indicative of KwaZulu Natal's efforts to diversify its energy mix and support the national grid with renewable and clean energy sources. The advancement of these projects reflects a significant step towards achieving energy sustainability in the region.

- **Gauteng:** Gauteng, being the economic hub of South Africa, has an available capacity of 4 680 MW by 2025, indicating potential for further power generation projects to support its substantial energy demand. Showcasing a variety of PV projects such as DRD SPV, Rhovan Vanadium Mine, and Lethabo 75MW solar PV, cumulatively contributing 530 MW towards the region's potential capacity as they are still in budget quotations status.

- **Limpopo:** Limpopo is projected to have a generation connection capacity of 3 360 MW by 2025, offering opportunities for new projects, particularly in areas such as renewable energy more so Solar PVs. List of PV projects including Mogalakwena Solar, Tubatse Ferrochrome - Tubatse PV Plant, and Amandelbult PV Plant, offering a combined capacity of 1 048 MW. A significant number of these projects, such as Mogalakwena Solar and Tubatse Ferrochrome - Tubatse PV Plant, have achieved budget quotations status, indicating readiness for grid connection.

- **Mpumalanga:** This area is expected to have 3 320 MW of available capacity by 2025. Given its historical significance in South Africa's coal-fired power generation, this opens possibilities for diversification into renewable sources. Features projects like Zibulo Solar Project and Ummbila Emoyeni Wind Energy Facility 1, adding up to 517 MW. All listed projects in this area, including Tutuka PS solar PV Plant and Hendrina South WEF, are tagged with BQ status, denoting their advancement in the connection process.

- **North West:** With an available capacity of 1 660 MW by 2025, the North West has room for new generation projects, including renewable energy initiatives. The province’s energy development is characterized by a strong emphasis on solar PV technology. Projects like RustMo1 Solar Farm and Bokamoso Solar Park are at the forefront of this drive, with a total added capacity enhancing the region's renewable energy output. The presence of multiple projects with budget quotations status in this area highlights the North West's role in South Africa's transition to a greener energy mix.

- **Free State:** The Free State is projected to have a connection capacity of 1 420 MW by 2025, suggesting potential for growth in power generation projects within the area. Includes several PV projects such as Braklaagte PV, DPT Hennenman Solar Farm, Good Hope 2 Solar Park, with a total potential additional capacity of 1 941 MW. Notable mentions of Khauta South Solar PV Facility and Ngonyama solar with budget quotations and awarded status respectively and each intended to have an installed capacity of 240 MW.

The depletion of generation capacity in key renewable regions highlights a significant challenge in South Africa's energy transition. Addressing this challenge requires substantial investment in the transmission network to unlock additional capacity for future projects. The GCCA 2025 emphasizes that such investments are crucial

but also notes that they take several years to develop and construct. In conclusion, it should be noted that generation connection capacity as per the Gride Connection Capacity Assessment for 2025 is not fixed; if network upgrades are implemented or if demand increases, the generation capacity of the system may increase[148].

3.4.3 Limpopo's Current Energy Landscape

The Limpopo Development Plan 2020-2025 provides a comprehensive outline of the province's strategies for economic growth, infrastructure development, and specifically the enhancement of its energy landscape. This plan is critical for understanding the strategic directions and priorities of the province in the face of global and local challenges, including the impact of the COVID-19 pandemic. Below is a detailed explanation of the key aspects related to the energy landscape and broader developmental strategies as outlined in the plan.

- **Sectoral Employment and Economic Backbone**: The LDP identifies the mining and utilities (electricity, gas, and water) sectors as the most labor-productive sectors in Limpopo, serving as the backbone of the province's economy. This emphasises the critical role of energy production and distribution in sustaining economic activities and growth within the province[149].
- **Geographical Concentration of Demand:** The plan highlights a significant concentration of utilities demand within specific municipalities - Polokwane, Fetakgomo Tubatse, and Musina. This concentration suggests areas with heightened energy needs, likely due to industrial activities, mining operations, or higher population densities, necessitating focused energy infrastructure development[150].
- **Infrastructure and Human Settlements:** The plan reflects on past investments in human settlements, which did not adequately achieve spatial transformation. It advocates for the development of human settlements in spatially targeted areas to support long-term sustainability and economic growth. This approach underscores the importance of robust energy infrastructure to support these development goals[151].
- **Impact of COVID-19:** The LDP notes that the global economic outlook was positive before the COVID-19 pandemic. However, the pandemic is anticipated to have a negative impact on economic growth in the short to medium term, posing challenges to energy demand and supply management, infrastructure development, and broader economic recovery efforts[152].
- **Infrastructure Development as a Key Action:** The LDP positions infrastructure development as crucial for unlocking the province's economic potential and improving the quality of life for its residents. It outlines specific actions, such as enhancing project management capacity, strategic maintenance planning, broadening the energy mix, ensuring compliance at landfill sites, and implementing key infrastructure projects. These actions are in line with the Limpopo Integrated Infrastructure Master Plan and District Development Model (DDM), aiming to create a sustainable and economically vibrant province[153].

In summary, the Limpopo Development Plan 2020-2025 takes a broad and far-reaching approach to enhance the province's energy landscape. It integrates energy sector development within a broader framework of sustainable development, economic growth, and infrastructural improvements. By focusing on these strategic

[148] Eskom Generation Connection Capacity Assessment (GCCA) (2025)
[149] Limpopo Development Plan (2020 – 2025)
[150] Eskom Generation Connection Capacity Assessment (GCCA) (2025)
[151] Eskom Generation Connection Capacity Assessment (GCCA) (2025)
[152] Eskom Generation Connection Capacity Assessment (GCCA) (2025)
[153] Eskom Generation Connection Capacity Assessment (GCCA) (2025)

areas, Limpopo aims to ensure long-term growth and sustainability Figure 33 gives a summary of Limpopo's strategic priorities as per the LDP.

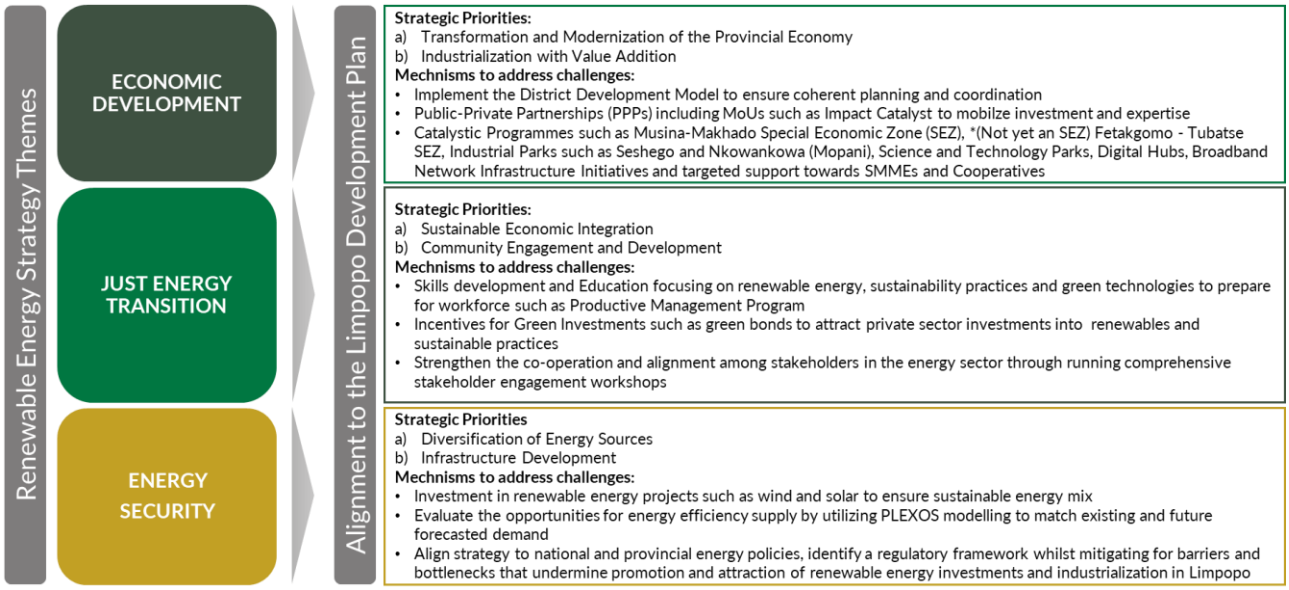


Figure 33: Key insights from the Limpopo Development Plan[154]

The renewable energy value chain (Figure 34) encompasses a series of interconnected stages that bring clean energy from source to consumption. It begins with the extraction or sourcing of raw materials, such as silicon for solar panels or rare earth elements for wind turbine magnets. These materials are then transformed into usable components like solar panels, wind turbine blades, or hydroelectric generators through manufacturing processes. International trade plays a role in moving these components between countries, facilitating project development in various locations. Once on-site, the renewable energy source captures energy from the environment (sun, wind, etc.) and converts it into electricity through generation facilities. This electricity travels over long distances via high-voltage transmission lines to reach population centers. Here, it's distributed through a network of substations and power lines for residential, commercial, and industrial consumption. Finally, at the end of the lifespan of the equipment, proper waste management and recycling strategies become crucial to minimize environmental impact and ensure the long-term sustainability of the renewable energy sector[155][156].

[154] Limpopo Development Plan (2020-2025)
[155] International Renewable Energy Agency (IRENA) (2019)
[156] Africa International Advisors (AIA) analysis

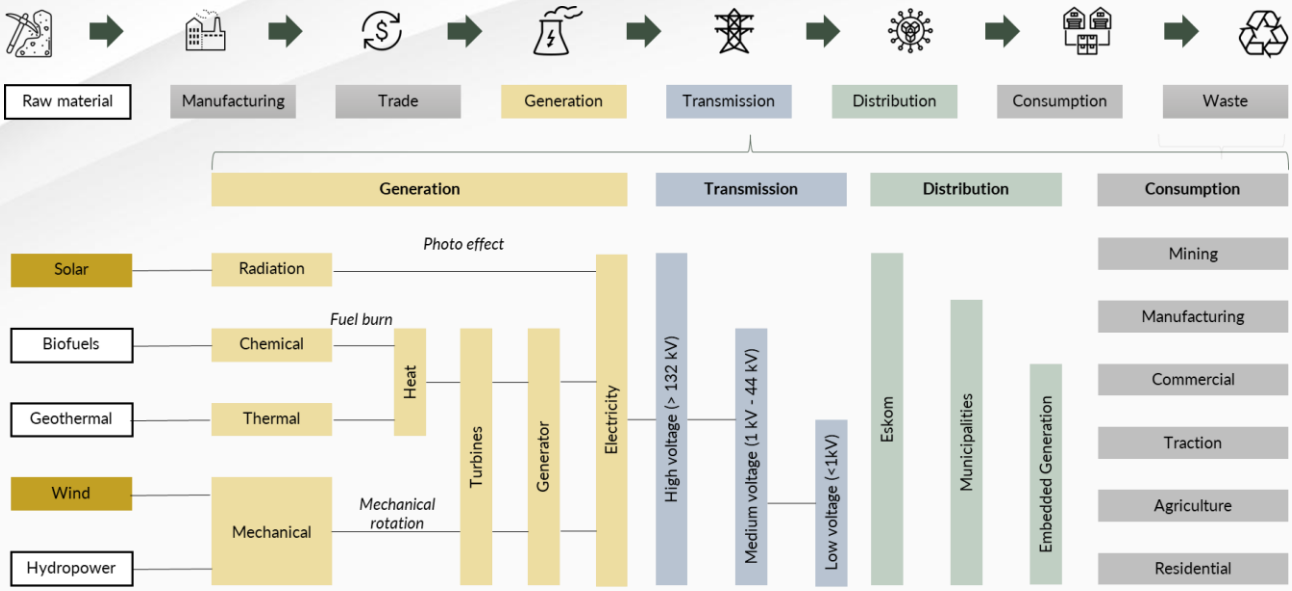


Figure 34: The renewable energy value chain[157] [158] [159]

Limpopo has the potential to be a significant player across the entire renewable energy value chain[160] (Figure 35) which needs to be explored:

- **Raw Materials**: Limpopo's geological potential should be explored for resources like lithium, nickel, cobalt, manganese, and graphite, crucial for energy storage technologies. Additionally, resources like silver, copper, and aluminium for solar PV technology (e.g., aluminium frames and trackers) could be investigated. For wind energy, the presence of rare earth elements like neodymium and yttrium for wind turbine magnets needs evaluation.

- **Manufacturing:** Limpopo could establish manufacturing facilities for wind turbine components, solar PV modules, and entire plant assembly. Local production fosters job creation and economic growth.

- **Trade:** Limpopo could prioritize the localization of manufacturing for renewable energy components. However, supplementing any domestic deficit with strategic imports may be necessary. Conversely, a surplus in production could open doors for exporting these components.

- **Generation:** Given the existing solar parks, Limpopo is well-positioned for further renewable energy generation. This would diversify the current energy mix, heavily reliant on fossil fuels, and contribute clean energy to the national grid. IPPs can play a vital role alongside Eskom in generation.

- **Transmission**: The National Transmission System Company of South Africa (NTCSA) plays a central role as a purchaser, market operator, and system operator, transmitting power bought from Eskom and IPPs across the country. Limpopo can leverage NTCSA's infrastructure for efficient transmission.

[157] National Energy Regulator of South Africa (NERSA) (2021)
[158] Green Rhino Energy (2016)
[159] Africa International Advisors (AIA) analysis
[160] Green Rhino Energy (2016)

- **Distribution:** The provincial grid's capacity and the roles of Eskom Distribution and municipalities need assessment. Considerations for embedded generation, where renewable energy is produced and consumed locally, should be explored for potential benefits.

- **Consumption:** Understanding sector-specific energy demands in mining, manufacturing, commercial, agricultural, residential, and transport sectors is crucial. This knowledge can inform targeted renewable energy solutions for each sector.

- **Waste:** Developing a robust strategy for decommissioning, reuse, recycling, and responsible disposal of renewable energy equipment at the end of its lifespan is essential for long-term sustainability.

By strategically developing its potential across these stages of the renewable energy value chain, Limpopo can contribute significantly to South Africa's clean energy future while fostering economic development and job creation within the province.

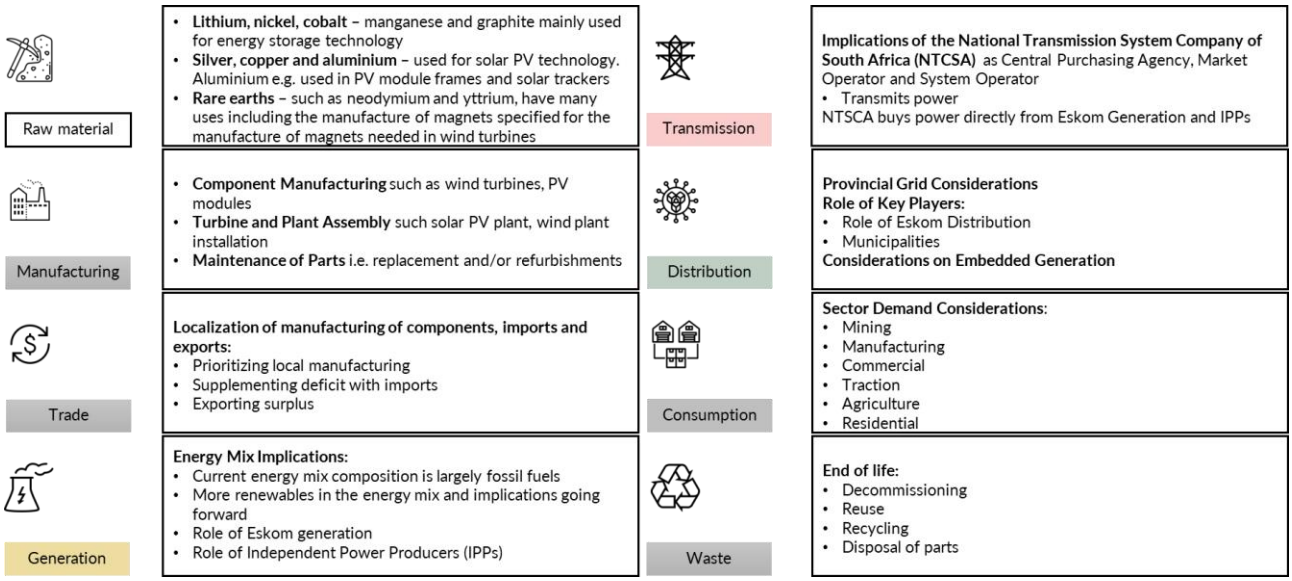


Figure 35: Opportunity for Limpopo to industrialise the value chain[161] [162] [163]

[161] Electricity Amendment Bill (2023)
[162] Eskom - National Transmission Company of South Africa (NTCSA)
[163] Africa International Advisors (AIA) analysis

As per the Eskom Transmission Development Plan (TDP) 2022, Limpopo is positioned for a significant transformation in its energy landscape, with a pronounced shift towards renewable energy integration and substantial infrastructure development. The province, historically reliant on coal and nuclear power stations, is witnessing an accelerated incorporation of renewable energy sources, particularly solar photovoltaic projects, which are set to contribute significantly to its generation capacity. Peak demand was projected to grow from 4 099 MW to 5 069 MW between 2022 and 2032 with generation increasing from 7 405 MW to 9 925 MW within the same period[164] (Figure 36).

Load drivers for Phalaborwa were due to increased electricity access, agriculture and chrome mining while Polokwane is forecasted to have increased electrification, with increased growth in agriculture and diamond and coal mining. As for Lephalale, increased load will be driven by commercial and light industrial sectors together with increased electrification. Overall, the TDP 2022 assume increased demand mainly driven by the mining and agriculture sectors[165].

The TDP demand forecasts give us various peaks for Limpopo's load; however, a more comprehensive and diligent forecast needs to be carried out taking into consideration District level demand profiles aggregated at a sectoral level. developments outlined in the TDP, such as the establishment of new substations and the expansion of 400 kV networks, underscore Eskom's commitment to enhancing the reliability and security of power supply in Limpopo, thereby catalysing economic growth and environmental growth and protection in the region[164].

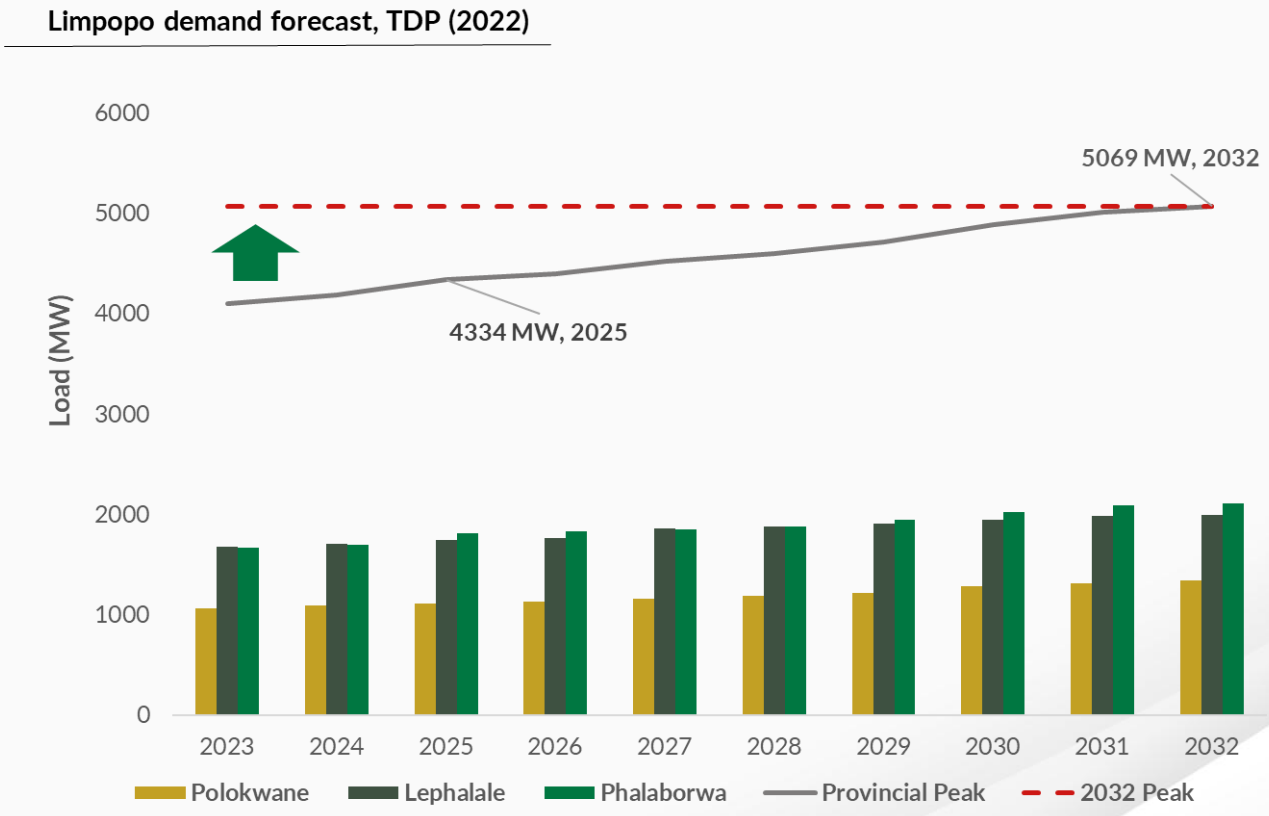


Figure 36: Limpopo demand forecast as per the Transmission Development Plan 2022

[164] Eskom Transmission Development Plan (2022)
[165] Africa International Advisors (AIA) analysis

Electricity from the mains is the dominant source for lighting amongst households in the province (Figure 37). Notably, all districts exhibit a reliance on electricity, ranging from 92.9% in Waterberg to 97.40% in Mopani. The use candle for illumination shows limited adoption, ranging between 1.6% (Mopani) to 4.4% (Waterberg). Paraffin usage appears even less frequent, with a range of a mere 0.2% and 0.4% across districts. Whereas solar power adoption ranges between 0.1% and 1.7%, potentially indicating a growing interest in renewable energy solutions for household lighting. The use of gas is another common alternative, ranging from 0.1% to 0.4% across the districts. Additionally, a small percentage (0.2% to 0.6%) falls under the "None" category, which could signify a lack of access to electricity or any form of household lighting, the highest being in the Vhembe District[166].

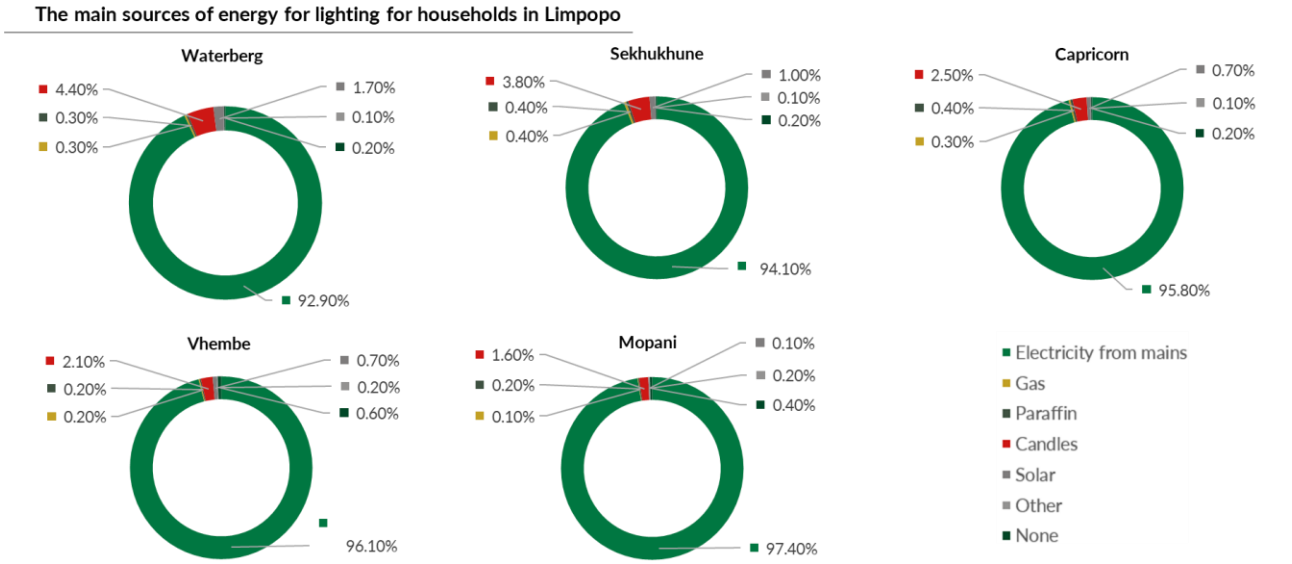


Figure 37: Main sources of energy for lighting for households[167]

The current state and projected future of household electricity access is depicted in Figure 38. Data from the 2021 Community Survey indicates that roughly 77% of Limpopo households, translating to approximately 1.23 million out of 1.6 million, currently have electricity access, with an anticipated increase in electrification across all districts by 2030[168].

Waterberg District is set to see the largest increase of 12% (from 78% to 90%), followed by Vhembe District with a projected rise of 9% from 76% to 85%, followed by Capricorn and Mopani expecting to grow by 8%[169]. Achieving these ambitious targets will likely require a combination of factors such as continued infrastructure development alongside targeted renewable energy initiatives which could significantly contribute to reaching an electrification rate of around 90% by 2030 for the province. However, it's important to note that this increased demand will necessitate additional generation capacity. Independent Power Producers could play a role to supplement Eskom's supply to meet the growing electricity needs of Limpopo households.

[166] Statistics South Africa (2022)
[167] Eskom Transmission Development Plan (2022)
[168] Eskom Transmission Development Plan (2022)
[169] Eskom Transmission Development Plan (2022)

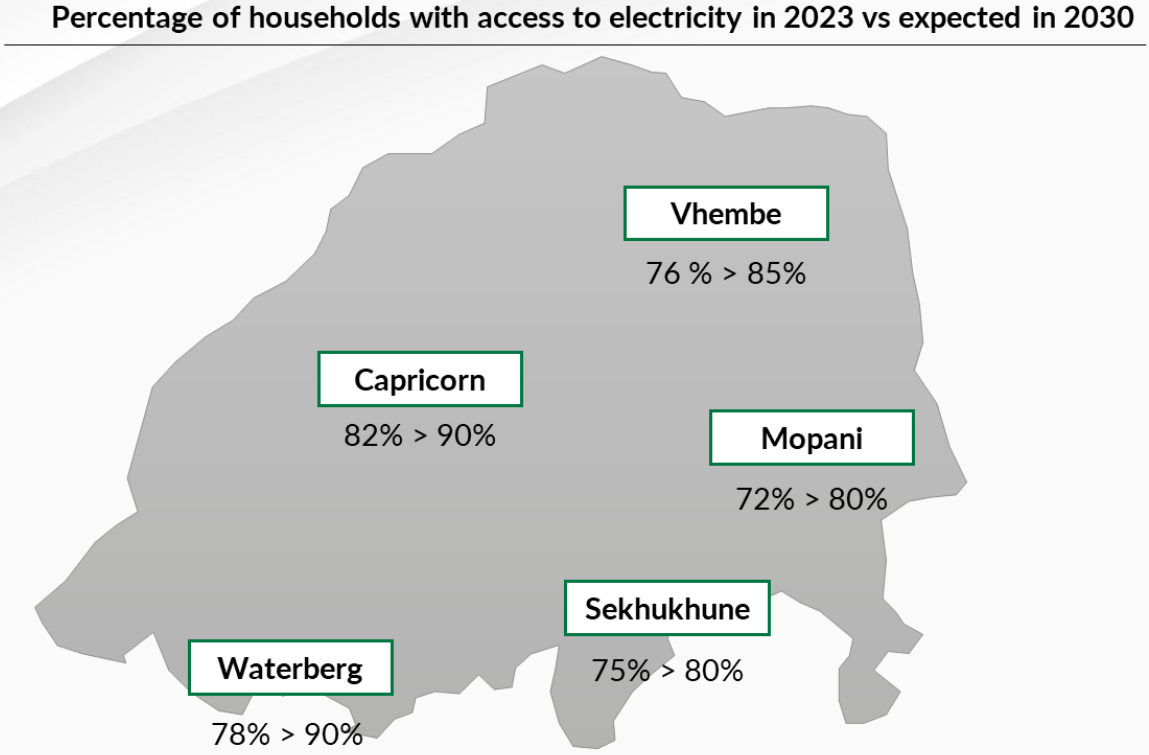


Figure 38: Current and future percentage of households with access to electricity[170]

The province currently benefits from a significant boost in clean energy generation from three solar parks: Witkop (33 MW), Soutpan (28 MW), and Tom Burke (66 MW) (Figure 39). Collectively, these parks contribute over 127 MW of renewable energy to the grid, enough to power tens of thousands of homes and reduce reliance on traditional sources. This not only aids in meeting the province's growing electricity demand but also promotes environmental sustainability, additionally, these parks have benefited from the REIPPP program, Witokop Solar Park (REIPPP 1), Soutpan Solar Park (REIPPP 1) and Tom Burke Solar Park (REIPPP 3).

- **Witkop Solar Park:** Located in Capricorn District with an installed capacity of 33 MW solar PV. Developed by a consortium including Globeleq Africa, Sturdee Energy, SunEdison, and TerraForm Global, it was commissioned in September 2014 and is currently owned by Phakwe Power. Spread across 75 hectares, the park utilizes ground-mounted solar panels and generates an estimated 62 GWh of electricity annually. Witkop operates under a 20-year Power Purchase Agreement (PPA) with Eskom Holdings SOC, selling electricity at a rate of $0.22 kWh with a contracted capacity of 30 MW[171].

- **Soutpan Solar Park**: Situated in the Capricorn District, this solar park contributes 28 MW of clean energy to the national grid as one of the first beneficiaries of the government's REIPPPP. Located on 180 hectares of land in the, the project utilizes 108 000 solar panels to generate approximately 61 GWh annually. This translates to powering over 13 000 South African homes with clean electricity. Soutpan Solar Power feeds directly into the Eskom distribution system via a 22 kV connection and operates under a 20-year Power Purchase Agreement with Eskom[172].

[170] Statistics South Africa (2022)
[171] Sturdee Energy (2022)
[172] Soutpan Solar Power (2022)

- **Tom Burke Solar Park:** Developed and owned by Enel Green Power, this Solar PV Park, a 66 MW solar energy facility located in Waterberg District. Commissioned in August 2016, the park utilizes ground-mounted solar panels across a 148-hectare area and generates 122 GWh of clean electricity annually. This translates to powering 38 000 households while reducing carbon dioxide emissions by an estimated 111,000 tons per year. The project represents a $122.1 million investment and operates under a 20-year power purchase agreement with Eskom Holdings SOC, selling electricity at a contracted capacity of 66 MW[173].

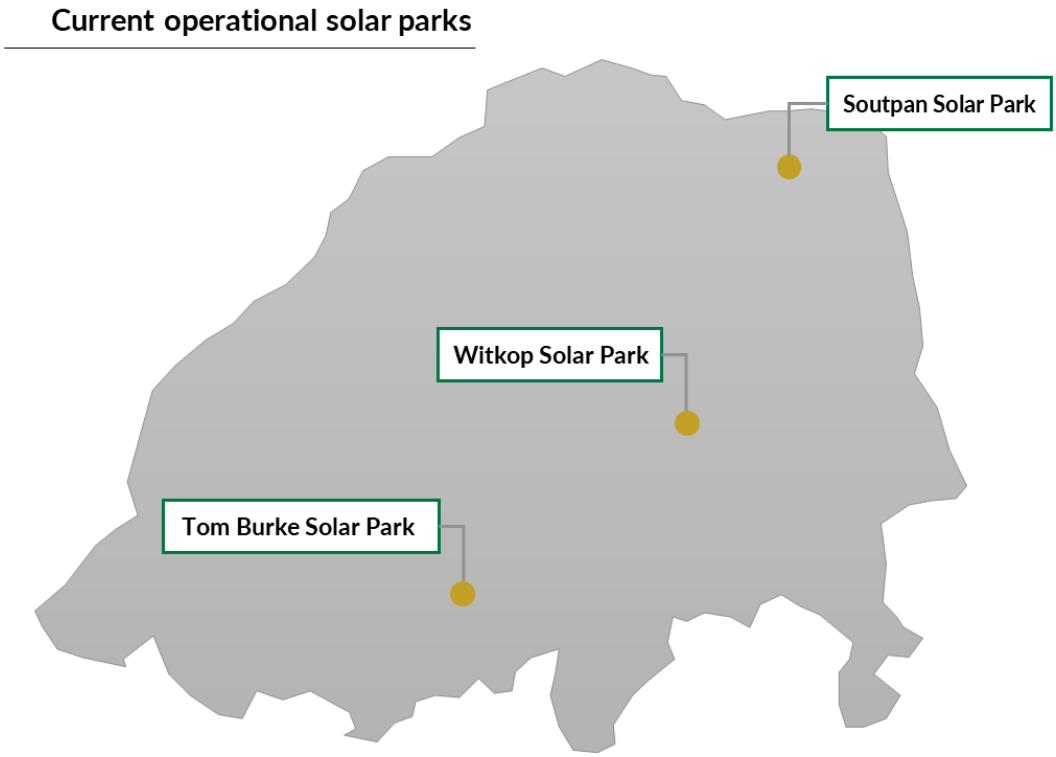


Figure 39: Current large scale solar parks in Limpopo[174] [175] [176]

In Limpopo, the Generation Connection Capacity Assessment 2025 reveals a strategic focus on enhancing the province's renewable energy generation, primarily through solar PV technology. This move aligns with South Africa's broader objectives of diversifying its energy mix and reducing reliance on traditional fossil fuels. The region's commitment to renewable energy is evidenced by a series of solar PV projects that have either achieved budget quotations status or are in various stages of development, contributing significantly to the province's generation capacity. Currently, the province has a committed IPP potential generation capacity of 930 MW (Figure 40) to be connected to the grid by 2025 leaving the province with 3 360 MW of connectivity capacity remaining[177].

At a high level, IPP projects such as Lion Thorn Solar 4 (145 MW) and Ingwe Solar Power Plant (150 MW), are among the largest projects. These two stand out for their ambitious capacity targets and their development will

[173] Enel Green Power (2022)
[174] Statistics South Africa (2022)
[175] Sturdee Energy (2022)
[176] Sturdee Energy (2022)
[177] Generation Connection Capacity Assessment (GCCA) 2025

significantly contribute to the province's renewable energy output, showcasing the potential of Solar PV in Limpopo province[178].

Committed IPP generation in Limpopo

Name of project	Technology	Capacity (MW)	Area	Status
Ingwe Solar Power Plant	PV	150	Tabor	BQ
Lion Thorn Solar 4	PV	145	Spitskop	BQ
Mogalakwena Solar	PV	100	Borutho	BQ
Baphalane (Bojating) Solar Farm Project	PV	100	Spitskop	BQ
Lephalale Solar	PV	80	Medupi PS	BQ
Bolobedu Solar PV Plant	PV	75	Spencer	BQ
Bela-Bela Solar Park	PV	75	Warmbad	BQ
Tubatse Ferrochrome - Tubatse PV Plant	PV	60	Merensky	BQ
Tubatse PV Chrome plant	PV	40	Merensky	BQ
Vangpan Solar PV Development	PV	40	Medupi PS	BQ
Namane Generation PV Plant	PV	30	Medupi PS	BQ
Stellar solar Farm	PV	20	Witkop	BQ
PPC Dwaalboom Solar PV 1	PV	10	Spitskop	BQ
Amandelbult PV Plant	PV	5	Spitskop	BQ

Figure 40: IPPs earmarked to be connected to the Limpopo grid by 2025[179]

The Generation Connection Capacity Assessment 2025 gives us a clear look at how Limpopo is getting ready for more renewable energy, focusing on solar power, however, it must be noted that detailed information of the low voltage network was difficult to attain. Keeping our focus more specifically on the substations and how much power they can handle, in places like Lephalale, Polokwane, Warmbad, and Phalaborwa (Figure 41). Moreover, the capacity expansion in these areas signals a move towards grid modernization, incorporating smart grid technologies to manage the variability of renewable energy sources effectively. Looking at the local areas[180]:

- **Lephalale:** In Lephalale, we see a considerable commitment with the Spitskop substation having a substantial 1 360 MW of capacity earmarked for connections. This capacity, however, is negated by Medupi and Matimba's 0 MW connection capacity, indicating either a current saturation in their ability to take on new connections or a strategic reserve for future expansion.

- **Polokwane:** Polokwane, being a big city in Limpopo, is set to be a hub of activity with substantial capacities at multiple substations: Spencer (960 MW), Witkop (1 400 MW), Borutha (1 400 MW) and Tabor (920 MW). These figures suggest a well planned for infrastructure development in readiness to incorporate a significant amount of renewable energy, boosting the regional grid's robustness and capacity.

- **Warmbad:** In Warmabd also known as Bela-Bela, the Pelly and Warmbad substations have 660 MW and 700 MW connection capacity respectively. These are moderate yet significant capacities that ensure the integration of renewable energies into the local grid, reinforcing energy security in the area. This area is getting attention because it's seen as a good place for new solar energy projects.

- **Phalaborwa:** Known for its mining activities, Phalaborwa displays a diverse array of substations with varying capacities: Acornhoek (1 360 MW), Merensky (1 420 MW), Leseding (2 000 MW), Foskor (299

[178] Sturdee Energy (2022)
[179] Sturdee Energy (2022)
[180] Sturdee Energy (2022)

MW). The notably high capacity at Leseding suggests a strategic positioning to become a significant node in the energy network, facilitating a high volume of power distribution from new generation sources.

Beyond the aforementioned mentioned projects, an additional 210 MW of solar photovoltaic facilities have secured approval. This includes a 10 MW facility by Northam, a 100 MW facility on Schoongezicht farm and a 100 MW facility within the PMC premises. Glencore Eastern Mines also has plans for a potential 70 MW solar PV facility with battery energy storage to be situated on the PMC premises.[181]

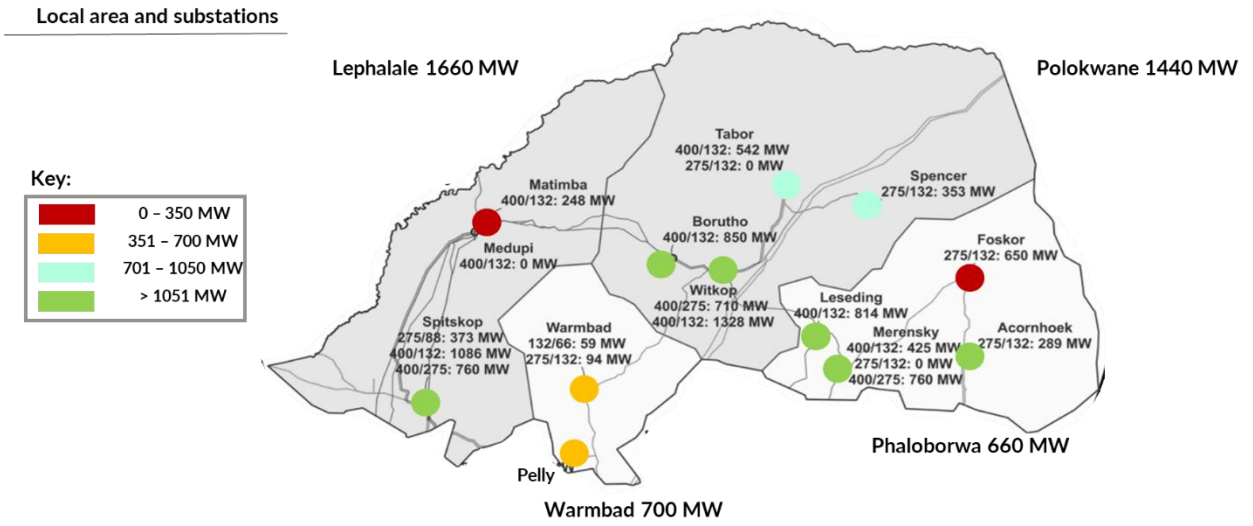


Figure 41: Limpopo local area and substation grid capacity, GCCA 2025[182]

The energy consumption patterns for household heating across five districts within the Limpopo province: Waterberg, Vhembe, Sekhukhune, Capricorn, and Mopani are crucial for understanding the current state of energy use and for strategizing the future direction of the renewable energy policy for the province (Figure 42).

In the Waterberg and Vhembe districts, a substantial reliance on electricity from the mains for heating suggests a level of modern energy infrastructure already in place, which can potentially facilitate a smoother transition to renewable energy sources. However, the predominant use of wood for heating in Sekhukhune (94.1%) and Mopani (43.8%) highlights a significant dependence on biomass, which poses sustainability challenges due to deforestation risks and the health impacts associated with indoor air pollution from wood-burning[183].

The negligible use of solar energy for heating across all districts, despite the high solar irradiance levels in Limpopo, indicates a substantial opportunity for solar technology integration. Leveraging the province's solar potential could substantially reduce the carbon footprint of household heating and align with global sustainable development goals.

Gas and paraffin usage is minimal, underscoring a gap in the market for clean cooking and heating fuels. Introducing biogas, for instance, could represent a renewable alternative that reduces reliance on non-

[181] LEDET
[182] Generation Connection Capacity Assessment (GCCA) 2025
[183] Statistics South Africa (2022)

renewable wood and paraffin, providing environmental benefits and possibly lowering energy costs for households.

For a renewable energy strategy focused on Limpopo, this data can be used to argue for targeted policy interventions. Prioritising the expansion of solar heating technologies could be advocated for, as well as exploring the potential of biogas and other renewable options. The data drives home the point that a strategic, district-specific approach is essential, given the diverse energy consumption patterns observed across the province. The transition to renewable sources for household heating in Limpopo must consider not only the environmental benefits but also the socio-economic impacts, ensuring that sustainable energy access contributes to improved living standards and economic opportunities for all residents.

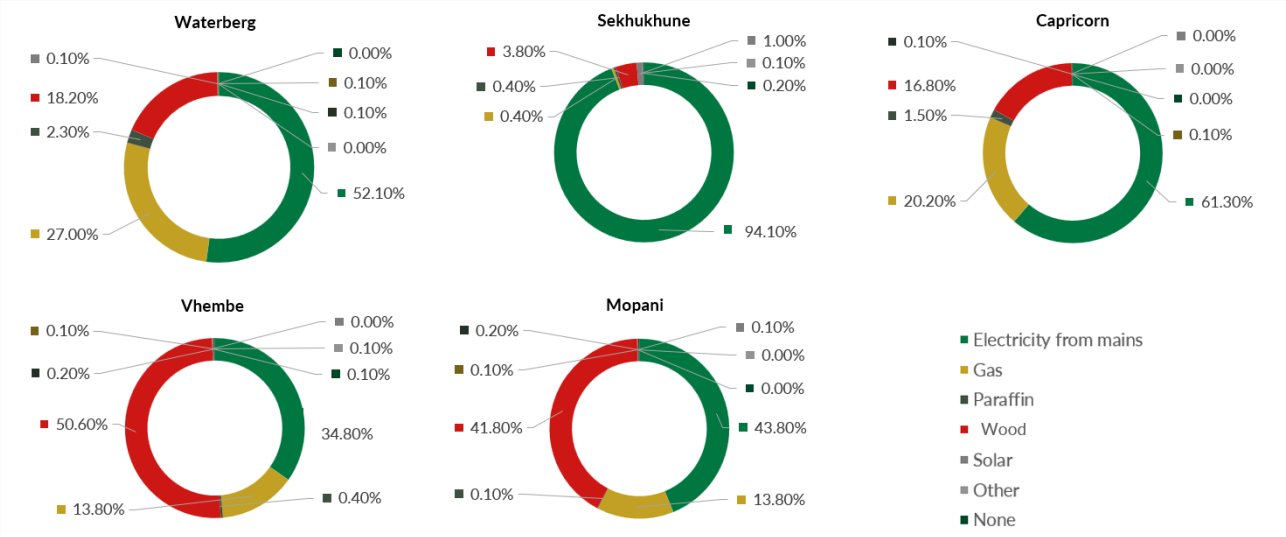


Figure 42 Main sources for heating for households in Limpopo[184]

The province of Limpopo holds a significant position in the potential development of biomass as a sustainable energy source. The Bio Energy Atlas has identified Limpopo as a region with substantial capacity for biomass energy production, due to its vast agricultural landscape and forestry resources. The following points encapsulate the core findings from the feasibility study and provide an outline for future energy planning in the province:

Feasibility of Biomass Energy Production Sites:
The study reveals that there are 91 feasible sites for biomass energy production within Limpopo. This finding is predicated on various factors, including land availability, biomass resource distribution, and access to necessary infrastructure. The geographic distribution of these sites aligns with the provincial map, which identifies key locations where biomass facilities could be optimally placed[185].

Energy Potential Capacity and Feedstock Limitations:
The typical biomass plants envisaged for these sites are medium-scale facilities, each with potential capacity of around 200 MW. This capacity aligns with current global trends where biomass plants are not constructed on the same scale as large fossil fuel power stations, primarily due to the differing nature of the feedstock supply chain. However, the development of these facilities is inherently linked to the availability of feedstock. The

[184] Statistics South Africa (2022)
[185] Bioenergy Atlas Beta

constraint imposed by feedstock availability emphasizes the need for a sustainable supply chain that does not compromise food security or biodiversity[186].

Power Generation Potential through Biomass:
It is estimated that Limpopo has an effective power generation potential of approximately 1 735 MW from biomass sources. This figure represents a significant contribution to the provincial and national power grids, with the potential to improve energy security and support South Africa's transition to renewable energy sources[187] (Figure 43).

Biomass to Energy Conversion Rates:
The conversion rate of biomass to energy is a pivotal metric in the planning of biomass facilities. The atlas indicates that on average, one ton (or 1 600ha of typical pine plantations) of dry woody biomass is required to produce 1 MWh of energy. This conversion rate is instrumental in determining the scale of biomass plantations needed, the logistics of transport, and the overall impact on land use[188].

In conclusion, the biomass potential in Limpopo presents a viable route towards diversifying the energy mix and advancing renewable energy targets. The feasibility study's insights are integral to developing a strategic framework that can leverage Limpopo's natural resources to foster sustainable energy production, stimulate local economies, and mitigate environmental impacts. The provincial government, in collaboration with national agencies and private sector partners, is poised to capitalize on this opportunity to establish Limpopo as a leading contributor to South Africa's renewable energy landscape.

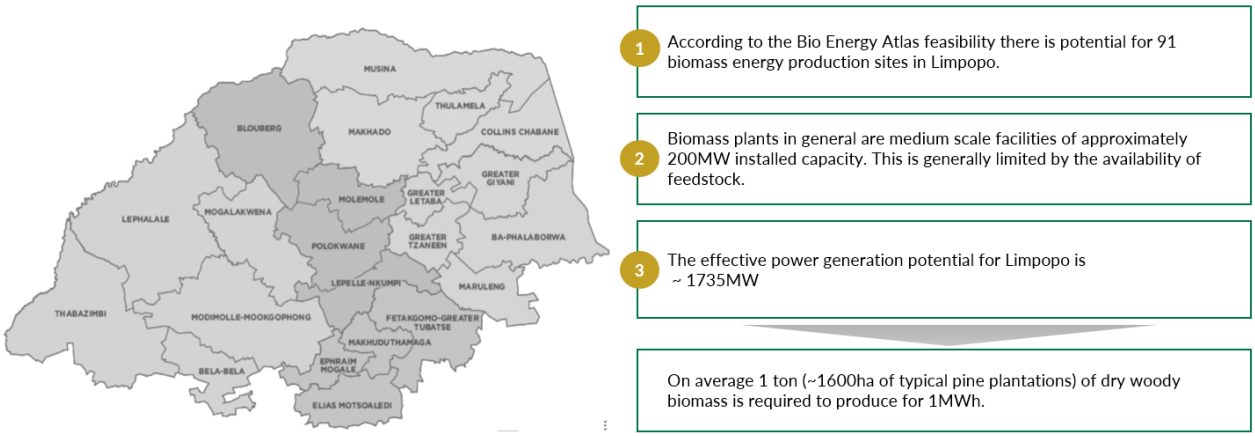


Figure 43: Limpopo biomass potential[189]

The Limpopo province possesses a significant opportunity to generate renewable energy through the conversion of animal and agricultural waste into biogas. This section examines the energy potential of various types of animal waste and the availability of different biomass sources that could contribute to a sustainable energy strategy (Figure 44).

Limpopo's robust livestock sector presents a promising avenue for biogas production. Data indicates that considerable amounts of energy can be harvested from livestock waste products. In the province of Limpopo, the potential for generating renewable energy from animal waste is significant, particularly given the high

[187] Bioenergy Atlas Beta
[188] Bioenergy Atlas Beta
[189] Bioenergy Atlas Beta

methane yield from cow manure. Readily accessible throughout the region, cow manure offers a dual benefit as a waste product and an energy resource; it is estimated that 25 tons of cow manure can produce 1 MWh of energy[190].

Similarly, pig waste, another byproduct abundant in Limpopo due to its reputation as a prominent pig farming hub, holds high methane potential as well. The conversion rate stands at approximately 24 tons of pig waste to generate 1 MWh of energy. Furthermore, chicken litter, a moderate methane producer found extensively in poultry farms across the province, requires about 2.5 tons to produce the same amount of energy (1 MWh). This capacity to transform animal waste into a valuable energy source presents an opportunity for sustainable energy practices within Limpopo's agricultural sectors[191].

The agricultural landscape of Limpopo yields a substantial amount of biomass, which could be harnessed for energy production. Notably, woody biomass and sugar syrup/molasses stand out as the most abundant sources, with each offering an impressive 1.6 million tons of potential availability per annum. Following closely is maize, which is a staple crop within the region and presents a significant biomass resource, with an annual availability of 1.5 million tons. This abundance of biomass resources underlines the province's capability to produce renewable energy at scale, positioning it as a key player in the drive towards sustainable energy solutions (Figure 42).

The Waterberg district, identified as the Red Meat Zone, is on track to surpass its production goals well before the year 2030. This progress ensures a continuous flow of manure which could be utilized for biogas generation. Additionally, with a population that surpasses 3.19 million and a robust annual growth rate in production of 9%, the capacity to produce biogas from poultry waste stands out as particularly noteworthy in the Sekhukhune and Capricorn districts. These insights underscore the significant potential for biogas energy production within the region, leveraging the by-products of its robust agricultural sector.

Harnessing the biogas potential from Limpopo's animal and agricultural waste can offer dual benefits of managing waste and producing renewable energy. By investing in biogas technology, Limpopo can reduce greenhouse gas emissions, improve waste management, and create a sustainable energy source that supports the local economy.

[190] Bioenergy Atlas Beta
[191] Estimating the Biogas Potential for Electricity Generation from the Agro-Waste Industry: A Resources Assessment for South Africa

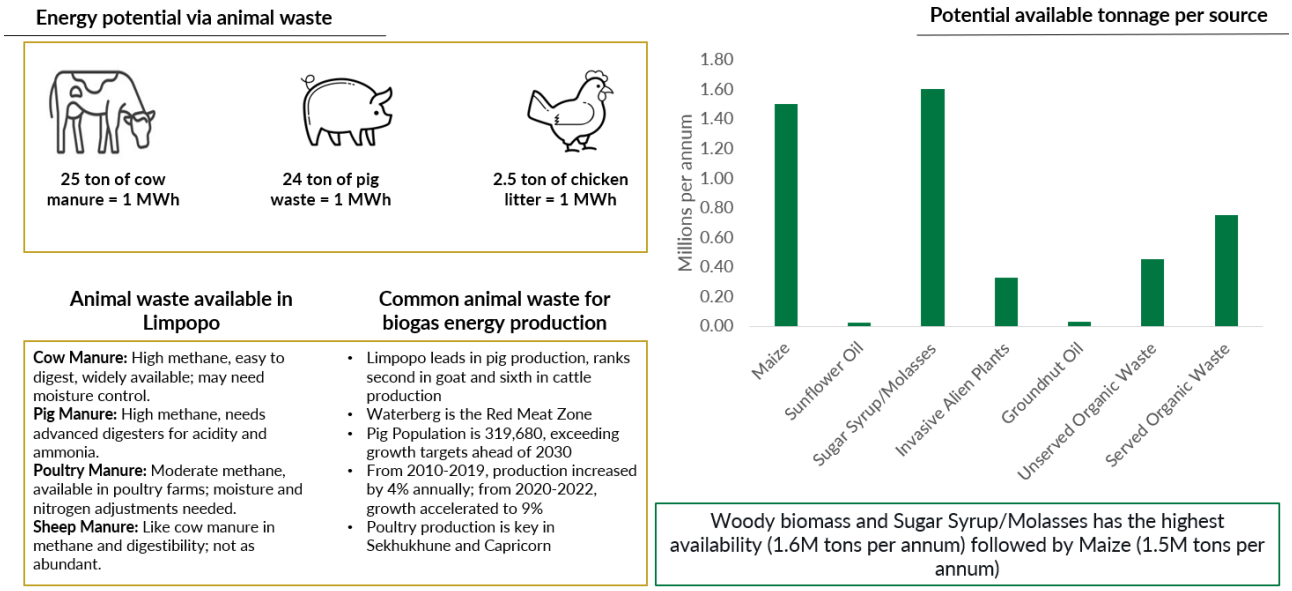


Figure 44: Biogas potential from animal and agricultural waste[192] [193]

Limpopo's rich biomass resources provide an outstanding opportunity for developing diverse bioenergy conversion technologies. Five distinct conversion processes offer viable paths for transforming biomass into energy, supporting the province's sustainable energy and waste management goals[194] (Figure 45).

- **Bio-coal Torrefaction:** Torrefaction is a thermal process that heats biomass in a low-oxygen environment within a temperature range of 200 °C to 300 °C. This method dries and carbonizes the biomass, turning it into a coal-like material known as bio-coal. Given Limpopo's biomass abundance, torrefaction could meet local energy demands and aid in managing organic waste, making it a fitting choice for the province's bioenergy strategy.

- **Thermochemical Conversion:** Biomass can undergo gasification, a process that converts solid biomass into a combustible gas mixture called syngas, comprising hydrogen and carbon monoxide. This gas can be used directly for electricity generation or as a feedstock for producing chemicals and liquid fuels. Implementing thermochemical conversion technologies in Limpopo could capitalize on the biomass waste and convert it into cleaner, usable energy.

- **Chemical Conversion:** In Limpopo, where agricultural output is substantial, chemical conversion, particularly transesterification, holds promise. This process converts fats into biodiesel and glycerol, using methanol and an alkaline catalyst. With crops like oilseeds being abundant, facilities for transesterification could be established, fostering a biofuel industry that creates sustainable energy resources while adding economic value.

- **Biochemical Conversion:** The biochemical conversion process, specifically anaerobic digestion, breaks down organic matter to produce biogas, primarily methane. This gas can be utilized for heating and electricity generation. The Vhembe district, for example, could exploit this technology by converting cattle and pig manure into biogas, potentially impacting around 625,000 homes, and harnessing the energy potential of the region's substantial livestock numbers.

[192] Bioenergy Atlas
[193] Estimating the Biogas Potential for Electricity Generation from the Agro-Waste Industry: A Resources Assessment for South Africa
[194] Stats SA - PPI New series from 2013 to 2024

- **Algal Biofuel Production:** Algal biofuel production is an emerging field that converts algae into bio-oil, a potential renewable fuel, along with small quantities of char and gas. Limpopo's environment, suitable for algae cultivation, could adopt fast pyrolysis methods to become more energy-efficient and sustainable. This process could also repurpose crop residues and food industry by-products, thereby supporting a circular economy.

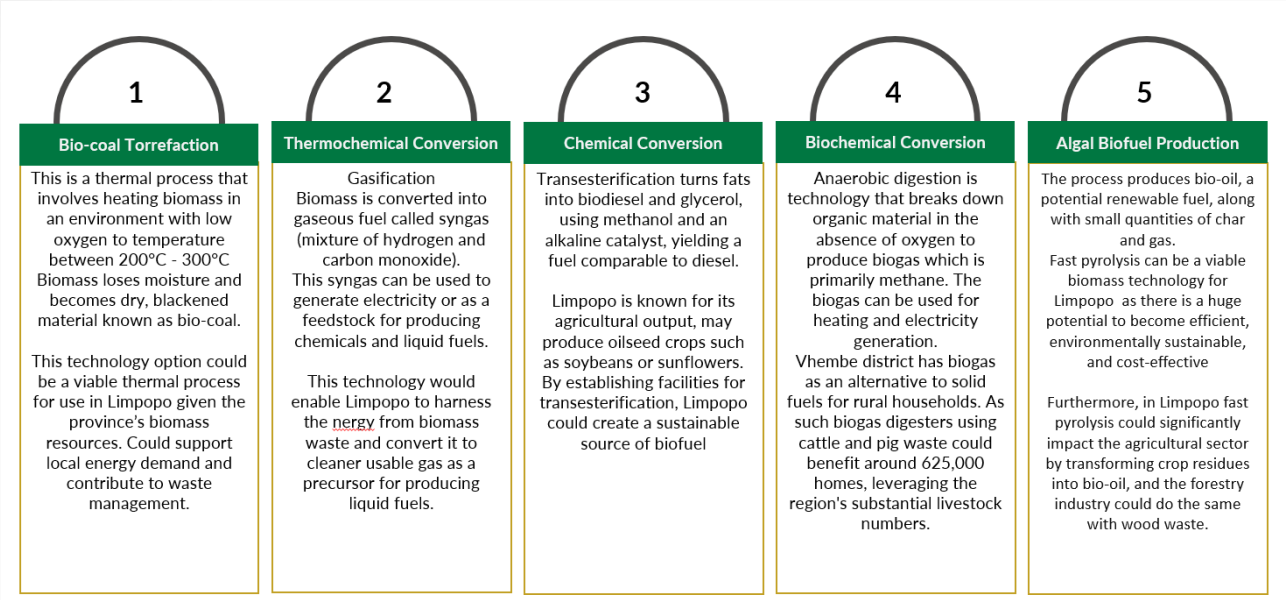


Figure 45: Biomass conversion technologies in Limpopo[195]

The various biomass conversion technologies presented offer a comprehensive framework for Limpopo to leverage its biomass resources. These technologies not only aim to produce energy but also integrate waste management, enhancing the province's transition to a more sustainable and circular bioeconomy[196].

As per Figure 46, there is potential to utilize biomass as a heating source more so in rural areas that are currently using wood as a heating element. With current LPG rates at 2.50 R/kWh, we can see that there are energy sources such as Bio-coal torrefaction, biomass integrated. Fast pyrolysis, simple anaerobic digestion and complex anaerobic digestion that seem to be comparable to the average LPG price. However, it should be noted that the least cost option for biomass of bio-coal torrefaction (1.48 R/kWh) is still not competitive to traditional fossil fuels such as coal and nuclear, however they are slightly cheaper than current solar PV and wind options at 1.99 R/kWh.

[195] BioEnergy Atlas Synopsis Report (2016)
[196] Stats SA - PPI New series from 2013 to 2024 was used to grow the unit cost for the biomass options from 2014 to 2022-2023

Technology option cost per feedstock.in Rand per KWh (R/KWh)

Biomass technology	2022	2023
Bio-Coal Torrefaction	1.27	1.48
Thermal Conversion	3.44	4.02
Biomass Integrated Combined Gasification Cycle	1.72	2.01
Fast Pyrolysis	1.83	2.14
Transesterification of Virgin Oil to Diesel	3.46	4.05
Simple Anaerobic Digestion	1.85	2.16
Complex Anaerobic Digestion	1.55	1.81
Average unit cost	**2.16**	**2.52**

Eskom unit cost per generation category in Rand per KWh (R/KWh)

Source cost	2022	2023	Percentage Change
Coal	0.44	0.49	▲ +12.07%
Nuclear	0.10	0.11	▲ +7.07%
Eskom-owned OCGTs	4.74	7.08	▲ +49.21%
IPPs	2.20	2.33	▲ +5.54%
a. IPP OCGTs	4.57	7.28	▲ +59.12%
b. Renewable IPPs	2.03	1.99	▼ -2.02%
International purchases	0.63	0.75	▲ +19.68%
Average unit cost	**2.10**	**2.86**	-

Figure 46: Comparative analysis of biomass technology and Eskom energy generation costs [197][198]

Limpopo's journey towards a sustainable energy future involves scaling various biomass technologies and integrating transitional energy sources like clean coal and gas. While biomass technologies such as bio-coal torrefaction, thermal conversion, and anaerobic digestion present promising options for renewable energy, their scalability is a crucial issue for power generation in the region[199].

Biomass technologies typically require a consistent and substantial supply of feedstock, such as agricultural waste or dedicated energy crops. In Limpopo, the availability of feedstock for biomass might be subject to seasonal fluctuations and land-use competition with food crops, which limits the scalability of these options. Moreover, the logistics of collecting, storing, and processing biomass can be complex and cost-intensive, potentially outweighing the benefits of localized biomass-to-energy conversion facilities.

To address these challenges, Limpopo can look towards integrating clean coal technologies such as Supercritical Coal-Fired Power Plants and Integrated Gasification Combined Cycle (IGCC) systems (Figure 47). These technologies offer improved efficiency and reduced emissions compared to traditional coal power stations, serving as a bridge towards more sustainable energy production without economic shocks. IGCC is well-suited to Limpopo's context, where coal reserves can be utilized to generate synthetic gas, which is cleaner and can be used to produce electricity or as a feedstock for other industrial processes[200].

[197] Stats SA - PPI New series from 2013 to 2024
[198] BioEnergy Atlas Synopsis Report (2016)
[199] Bioenergy Atlas Synopsis Report (2016)
[200] Stats SA - PPI New series from 2013 to 2024 was used to grow the unit cost for the biomass options from 2014 to 2022-2023

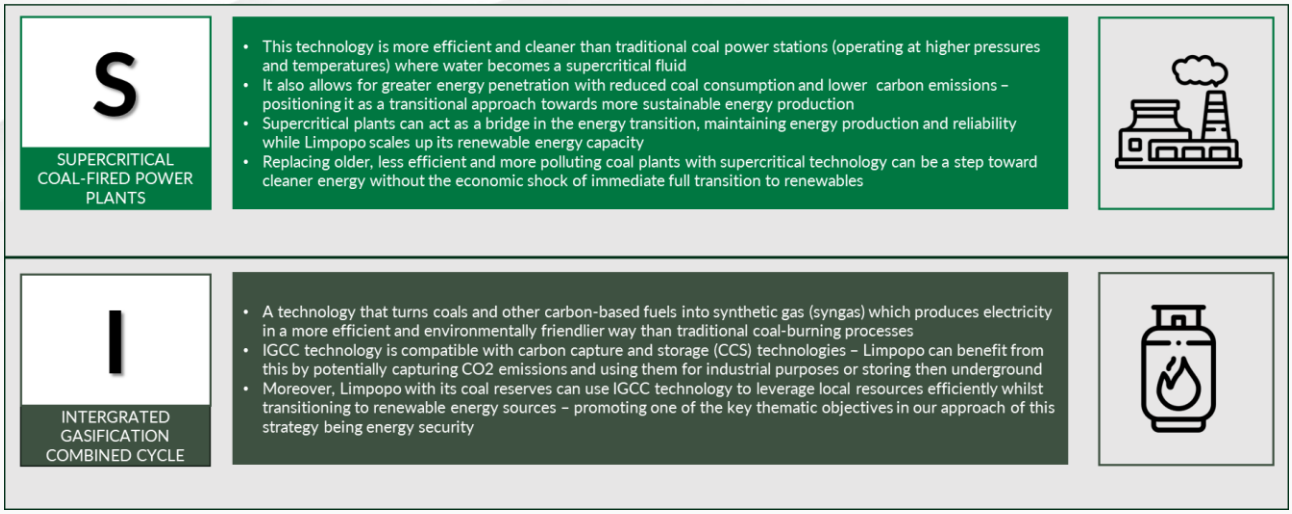


Figure 47: Clean-coal options[201]

Liquefied Natural Gas is another complementary transition fuel. It provides the flexibility of transporting natural gas to areas beyond the reach of pipelines, thereby enhancing the energy supply's global accessibility. With strategic locations like Vhembe and proximity to Mozambique, a leading LNG supplier, Limpopo can strengthen its position as a key player in the regional energy market and make strides in the Just Energy Transition.

Power-to-Gas (PtG) technology can further facilitate this transition in Limpopo (Figure 48). By storing excess renewable energy and reconverting it back to electricity during peak demand, PtG technology can improve grid stability and energy security. This is particularly relevant in remote areas where energy access is limited. The deployment of PtG technology, alongside renewable energy sources, can promote energy equity, stimulate job growth, and encourage industry innovation[202].

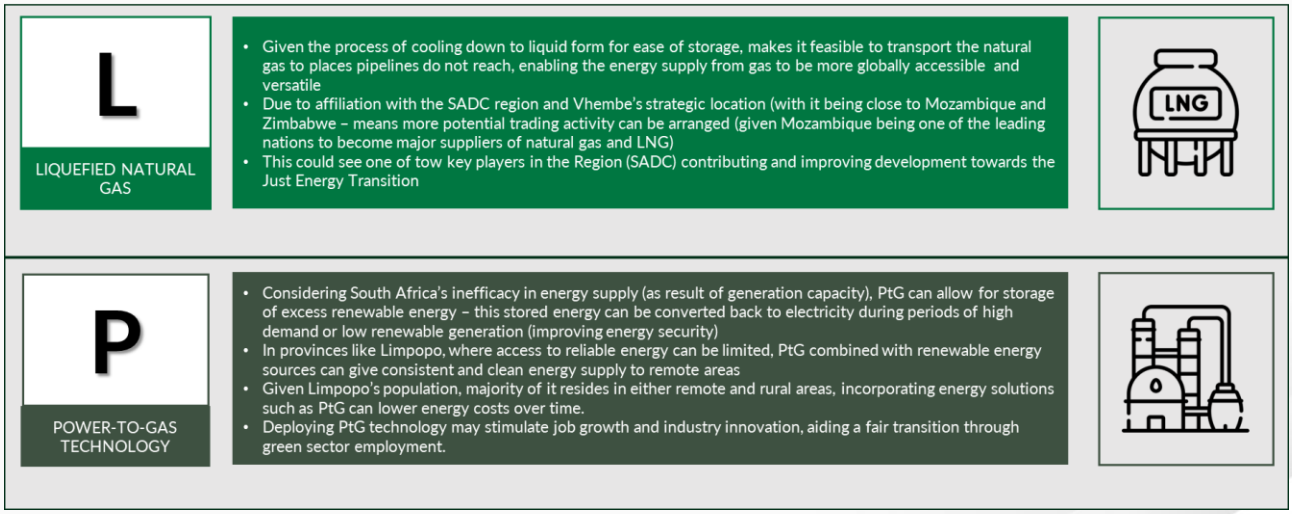


Figure 48: LNG and Power-to-Gas option[203]

[201] Stats SA - PPI New series from 2013 to 2024 was used to grow the unit cost for the biomass options from 2014 to 2022-2023
[202] Bioenergy Atlas Synopsis Report (2016)
[203] Bioenergy Atlas Synopsis Report (2016)

The scalability issues of biomass options for power generation can be addressed through a balanced energy mix that includes advanced coal technologies and natural gas, which act as necessary transitional solutions. This approach would ensure energy security and provide the necessary flexibility and stability to Limpopo's energy grid as the province moves towards an increasingly renewable energy portfolio. The integration of these technologies should be part of a strategic plan that supports local economic development while aligning with environmental sustainability goals.

It's worth noting that the process of getting approvals to implement a renewable energy project can be a lengthy and complicated ordeal. In fact, it can take up to 65 months from the initial idea to the actual execution, as shown in Figure 49. This underscores the importance of careful planning and strategy in the early stages of the project's lifecycle. Each phase builds on the previous one, so any delays or oversights can lead to complications or cost overruns down the line.

The Environmental Impact Assessment (EIA) and licensing phase is typically the most complicated stage due to regulatory and environmental concerns. Therefore, it's essential to have a well-thought-out plan to navigate the legal landscape and ensure compliance. The outcome of the EIA can significantly impact the project's financial aspects, so it's crucial to consider potential mitigation measures early on to avoid costly adjustments later. However, a successful EIA can also reduce regulatory and environmental risks, making the project more appealing to investors[204].

In the power project lifecycle, the successful completion of the EIA and financial closure stages marks the transition from planning to execution. These stages establish the groundwork for the project's sustainable and financial viability, ensuring that it aligns with environmental standards and has a solid economic foundation to proceed into the construction and operational phases. The operation phase, which can last for several decades, requires constant attention to technical performance and maintenance, adaptability to changing regulatory and technological environments, and the implementation of sustainable practices. This phase is critical to the project's overall success and longevity[205].

Finally, it's essential to plan for decommissioning from the outset, even during the project's construction. This phase is relatively short but crucial for ensuring environmental protection and can influence design and operational practices. A well-executed lifecycle approach ensures that power projects are sustainable, compliant, and economically viable throughout their entire lifespan. As you can see, the project lifecycle for power projects is complex and requires careful consideration, significant investment, and a long-term commitment to ensure success.[206]

[204] Environmental Impact Assessment (EIA) – Manual EIA (2017)
[205] Bioenergy Atlas Synopsis Report (2016)
[206] Investigating the financial close of projects within the South African REIPPPP

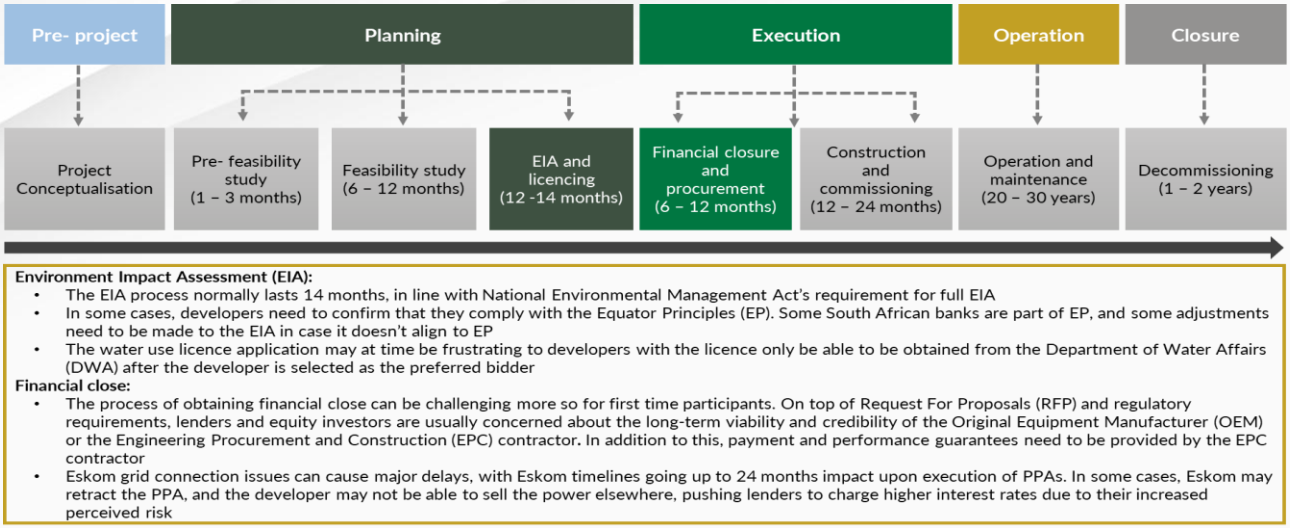


Figure 49: The standard lifecycle of approvals to implement a renewable project[207]

3.5 Strengths, Weaknesses, Opportunities, and Threats

Defining our Strengths, Weakness, Opportunities and Threats (SWOT):

- **Strengths:** What capabilities are within our control to execute on our renewable energy strategy
- **Weaknesses:** What gaps are within our control that detract from the strategy
- **Opportunities:** Trends in the environment that enable success of the renewable energy strategy
- **Threats:** Trends in the environment that put the strategy at risk

Table 5 represents out analysis of the SWOT.

[207] Investigating the financial close of projects within the South African REIPPPP

Table: 5 SWOT analysis

Strengths	• **Abundant renewable resources:** Limpopo enjoys considerable sunshine, some wind potential, providing diverse renewable energy options • **Government support:** The national and provincial governments have pledged commitment to renewable energy, implementing policies and incentives like feed-in tariffs and REIPPPP programs. We have gone to Bid window 7 for REIPPP • **Raw materials:** Raw materials such as Platinum Group Metals (PGMs) that can be beneficiated for component manufacturing • **Growing public awareness:** Increased environmental consciousness and concerns about climate change are driving public support for renewable energy adoption • **Existing infrastructure and plans for increased investment:** Existing grid infrastructure in some areas can facilitate integration of renewable energy sources as there is still capacity available. Grid capacity available in Limpopo is 3 360 MW up to 2025. There are several IPPs that have achieved budget quotations status and ready to be connected to the grid, with an additional capacity of 930 MW • **Improved regulatory environment:** Increasing of the licence exemption from 1 MW to 100 MW • **Unbundling of Eskom:** The unbundling of Eskom means the market, more so at generation and distribution levels, will become decentralized making it competitive and potentially having positive impacts on end consumers • **Key policies alignment:** There is alignment of Eskom's TDP plans for electrification up to 2032, GCCA 2025 and Limpopo's strategy of incorporation of renewables into its energy generation. To add, Bid window 6 projects from IPPs have been incorporated in the GCCA 2025 report • **Understanding of load and generation forecasts:** There some understanding of sectoral demand and potential generation capacity up to 2032 from TDP 2022 • **Increased generation through biomass**: Although scale is required, there is potential for agricultural sector to generate renewable energy through modular solar PVs and biomass

Weaknesses	• **Cable theft and vandalism:** In the current energy system, cable theft and a vandalism is a big problem and concern that can potentially derail the successful implementation of renewable energy infrastructure • **Infrastructure transitioning:** Eskom owns most of the infrastructure and some if not most of the infrastructure is ageing • **Misalignment of some key policies:** There are some policies that are misaligned at global, national and local level for example, it is not clear the actual definition of a "Just Energy Transition" with national policies defining this term differently with global ones having a somewhat divergent viewpoint. Making the definition at a provincial level quite important at this juncture • **Capacity needed may be lacking:** The level and amount of capacity needed in terms of skills for example component manufacturing to maintenance, falls short • **Land use issues:** Implementation of renewable energy projects such as Solar PVs require large amounts of land, some concerns exist over the use of agricultural land for renewable projects. In addition, issues such as Permission to Occupy (PTO) agreements not being in place between traditional leaders and projects can adversely derail project execution • **Financial limitations:** There investment capacity needed and allocated by the provincial to implement an infrastructure change to accommodate renewables will be substantial • **Limited industrial base** Currently there is an insufficient industrial base to deliver on industrializing the value chain. The SEZs such as FTSEZ and MMSEZ offer some potential, but their completion needs to align to the execution of the renewable energy strategy • **Rural and low-income households dependent on carbon intensive energy sources:** Currently, energy sources for rural locations is from carbon intensive sources such as firewood, placing the environment at risk of deforestation • **Competitiveness of the price of renewable generation:** At the moment generation sources such as coal-powered station and nuclear are better priced compared to renewables • **Issue of meeting Limpopo's load:** The intermitted nature of renewables makes them unreliable to meet base load requirements. Even with battery storage, solving for this issue will be a challenge • **Currently more than 80% of Limpopo is coal-based electricity:** Currently more than 80% of generation capacity is from Eskom and through Fossil sources

Opportunities	• **Increasing awareness:** There is potential to increase the awareness of the community at large to ensure alignment on the importance of conserving the infrastructure that will be put in place. Asset Based Community Development (ABCD) projects will ensure the safeguarding of said projects • **Holding stakeholder engagements:** Holding engagements will the public, private, academics and community will ensure there is buy-in from all relevant stakeholders • **Fostering and improving skills development:** TVET and FET colleges have the potential to implement academic programmes to support the implementation and operation of the renewable energy eco-system. For example, the University of Venda indicated they will implement academic programmes that will focus on renewables • **Increasing collaboration:** There is potential to increase collaboration, and investments through Public-Private Partnerships (PPPs) to bridge the investing options as when as increasing participation of disadvantage groups such as women and the youth • **Municipalities role in distribution and storage:** Apart from distributing of power, municipalities can invest in storage capacity through batteries to store surplus power from embedded generation for instance, to be sold back to the various demand sectors during low intermittency periods • **Earmarking for investments towards renewables:** The provincial government can further grow the renewable energy eco-system by allocating more funds to the sector • **Renewables are sovereign sources:** Unlike fossil fuel, renewable energy sources such a wind and solar radiation are sovereign sources allowing the province at large to make its own decisions regarding energy generation • **Decreasing LCOE:** Through technology improvements, the Levelized Cost of Energy is graduation decreasing through the most recent RE-IPP bid windows. Through localized production and sourcing of raw materials, this cost can be further reduced • **Decommissioning of coal fleet:** With the decommissioning of the coal-fleet, renewables and other supply energy supply sources can be used to replace the generation gap they are potentially to leave • **Potential for job creation:** Through industrialization of the value chain, the strategy and implementation plan can lead to increased job creation. Though localized production of components, project management of projects amongst other relevant roles needed to execute on the strategy • **Sparely located demand can be solved for:** Currently, locations that categorized by Eskom as rural areas i.e. areas outside the town/city which are sparsely populated, can take advantage of modular solar panel installations to complement their current demand. With the potential to sell excess power back to the gird and earn an additional income • **Opportunity to take advantage of push to NZE by 2050:** With the country pushing towards zero carbon emissions by 2050, this has built the case for implementation of more renewable projects due to their lower emissions in energy generation thus mitigating for climate change

	• **Use of alternative generation sources to support transition:** Limpopo can make use of other alternative energy sources such as clean coal, LNG to support the transition to renewable • **Potential facilitation into the SADC region:** Due to Limpopo's strategic location and interconnectedness to other geographical locations, it can take advantage of this as a gateway to other markets through trade
Threats	• **Misaligned policies**: The Eskom MTSAO and Limpopo's provincial policies for example may have misalignment more so on the strategy execution of renewables. If Eskom was to fully concentrate on security of supply and in turn utilizing the pathways to delay the decommissioning of the coal fleet • **Grid constraint issues:** Currently there is still grid capacity in Limpopo, however with increased IPP connections into the grid, this needs to be followed with increased investment of the infrastructure • **Exposure to global shocks due to importation of components:** Currently no local manufacturing capacity exposed to global dynamics due to exchange rate fluctuations, constant changing trade dynamics and geopolitical tensions • **Change in market dynamics:** Change of market dynamic from wholesale to retail may drive the complexity further • **Complexity of transition:** Municipalities do not have the technical capacity and know-how regarding the complexity of the transition as it complicates energy management • **Fossil fuel sector is still a signiant energy player:** Key carbon centred could be left behind if not properly catered for in the transition process, more so from a job perspective • **Eskom owns majority of the infrastructure:** With Eskom owning most of the infrastructure in the energy value chain, there is a risk of them not actually investing to improve it, considering the debt owned by some of the municipalities

The information from the baseline assessment has been used to develop a comprehensive understanding of Limpopo's current energy situation and to inform the development of the strategy. The Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, a key component of the baseline assessment, has been incorporated into this report. This analysis identified Limpopo's strengths, such as an abundance of renewable resources, including considerable sunshine and some wind potential, offering diverse renewable energy options, and national and provincial government support for renewables. Weaknesses identified in the baseline assessment included an over-reliance on traditional energy sources, like firewood, particularly in rural and low-income communities, and ageing infrastructure. The SWOT analysis also highlighted opportunities for future growth, such as public awareness campaigns and skills development programs to address the potential lack of capacity for component manufacturing and maintenance within the renewable energy sector.

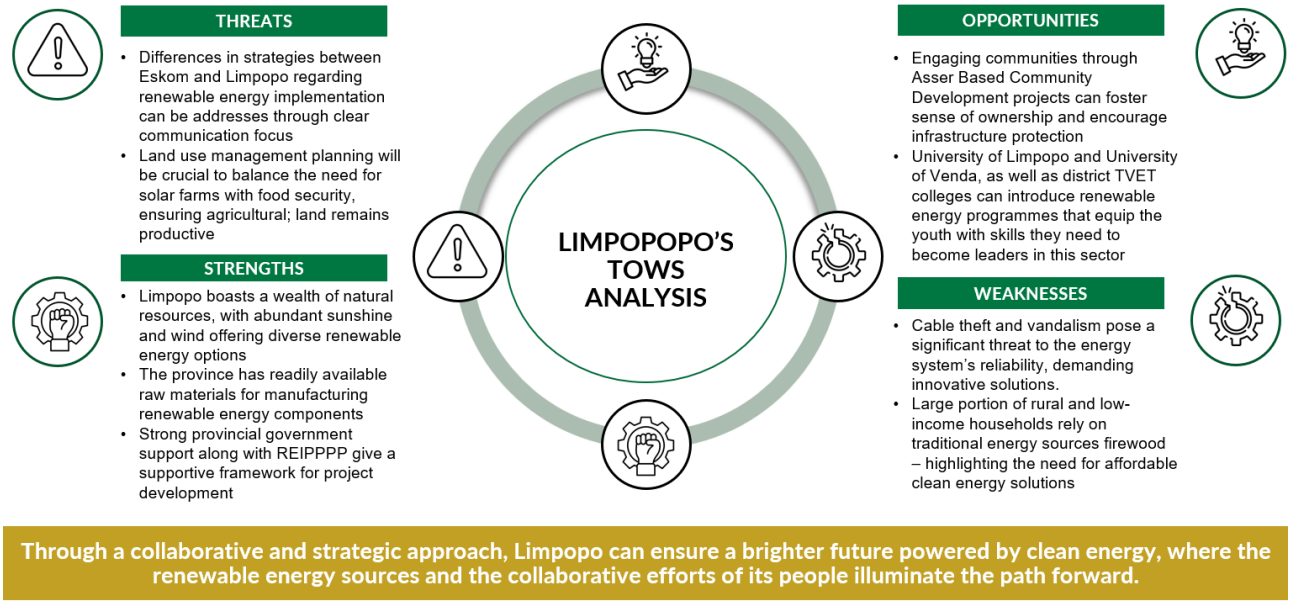


Figure 50: TOWS Analysis

3.6 Industrialization of Renewable Energy Value Chain

Renewable energy technologies like solar PV and wind are becoming increasingly cost-competitive, dropping significantly in price over the past decade. This, coupled with climate change concerns, has driven a global boom in renewable energy deployment, supported by falling battery storage costs. As a result, the global share of electricity generation from renewables has risen from 18.6% in 2000 to 28% in 2021[208]. South Africa is following this trend. While initial deployments focused on pilot projects, the government's REIPPPP program launched in 2011 significantly accelerated the rollout of large-scale renewable energy. Battery storage procurement began in 2022, and the private sector is becoming increasingly involved. Additionally, many municipalities are encouraging residential and commercial adoption of solar PV and battery systems.

In the future, the global renewable energy market is expected to reach between 5.4 TW and 10.8 TW by 2030, driven by decarbonization efforts and new demands like green hydrogen[209]. The battery storage market is also projected for exponential growth. South Africa reflects this trend, with ambitious government plans for utility-scale renewable energy and battery storage procurement by 2030. Additionally, various government departments and provinces are planning large-scale renewable energy deployments. Private sector investment is also surging, and small-scale embedded generation installations are expected to rise due to rising grid electricity prices and growing energy security concerns.

This booming market presents a significant opportunity for South Africa. The South African Renewable Energy Masterplan (SAREM) aims to leverage this opportunity by focusing on developing the domestic value chains for solar, wind, lithium-ion, and vanadium-based battery technologies. This approach aligns with global trends and South Africa's existing manufacturing capabilities. SAREM paves the way for economic development, job creation, and social transformation through a more inclusive rollout of renewable energy and storage solutions.

This presents exciting possibilities for Limpopo to contribute to the country's clean energy goals and achieve economic development via the renewable energy value chain (Figure 51). This can be achieved via:

[208] Investigating the financial close of projects within the South African REIPPPP
[209] The South African Renewable Energy Masterplan (SAREM) (2023)

1. Localization for Economic Development:

    - **Manufacturing:** Limpopo has the potential to become a manufacturing hub for renewable energy components. This could include:
        - **PV modules:** Manufacturing solar panels would require establishing factories to produce silicon wafers, solar cells, and assemble the final modules.
        - **Wind turbine components:** Components like blades, towers, and nacelles could be manufactured in Limpopo, creating skilled jobs and boosting the local economy.
        - **Battery storage systems:** As battery storage becomes increasingly crucial, Limpopo could explore manufacturing lithium-ion batteries or components.

2. Raw Material Potential:
    - **Critical Minerals**: Limpopo's geological makeup could hold resources vital for renewable energy technologies.
        - Cobalt and Rare Earth Elements: These are essential for magnets in wind turbines and electric vehicle motors. Exploring and potentially mining these resources could position Limpopo as a supplier within the value chain.

3. Manufacturing Considerations:

    - **Skills Development**: Investing in training programs to equip the workforce with the necessary skills for renewable energy manufacturing is vital.
    - **Infrastructure Upgrade**: Upgrading transportation infrastructure to efficiently move raw materials and finished products is necessary.

4. Trade: Limpopo's potential for abundant renewable energy generation, particularly through solar projects, can open doors for electricity trade with neighbouring countries and provinces. If Limpopo produces surplus power beyond its own consumption needs, there can be opportunities for:

    - **Interprovincial Power Trading:** Limpopo could participate in South Africa's national electricity grid, selling excess power to provinces experiencing higher demand or facing generation shortfalls. This can be facilitated through existing power purchase agreements with Eskom or directly with other provinces.
    - **Regional Power Pools:** Limpopo could contribute to the regional power pools like the Southern African Power Pool (SAPP)[210]. Membership allows for electricity trading between member countries in Southern Africa, creating a broader market for surplus power and potentially fetching higher prices.
    - **Direct Power Purchase Agreements:** Limpopo could negotiate directly with neighbouring countries, like Botswana or Mozambique, to establish power purchase agreements. This approach allows for customized pricing and contract terms specific to each neighbouring country's needs.

By strategically developing its renewable energy capacity and exploring these trading options, Limpopo can not only ensure its own energy security but also become a reliable electricity exporter, contributing to regional energy stability and economic growth.

[210] Eskom Integrated Report (2023)

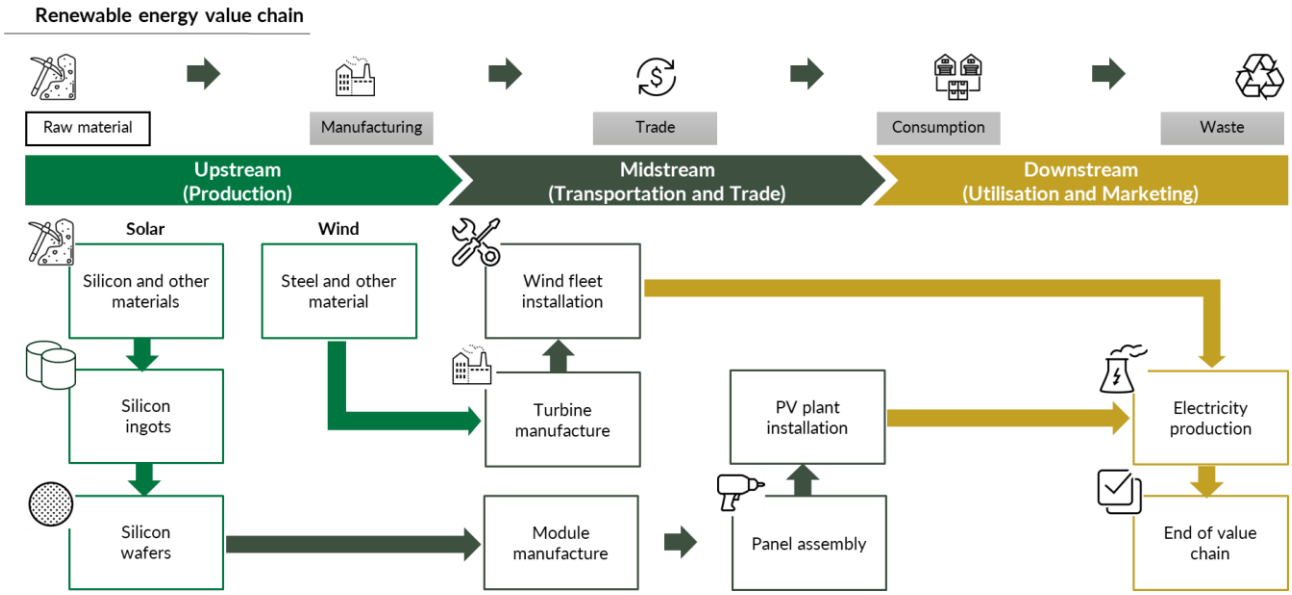


Figure 51: Renewable energy value chain[211]

Additionally, SAREM also encourages exploring diverse renewable energy sources where Limpopo could consider relating to the battery storage value chain (Figure 52):

- **Battery Storage:** Manufacturing or assembling battery storage systems would support Eskom's grid stability and enable greater renewable energy integration.
- **Hydrogen Fuel Cells:** Hydrogen, potentially produced using renewable energy, could be a clean fuel source for transportation and industrial applications.

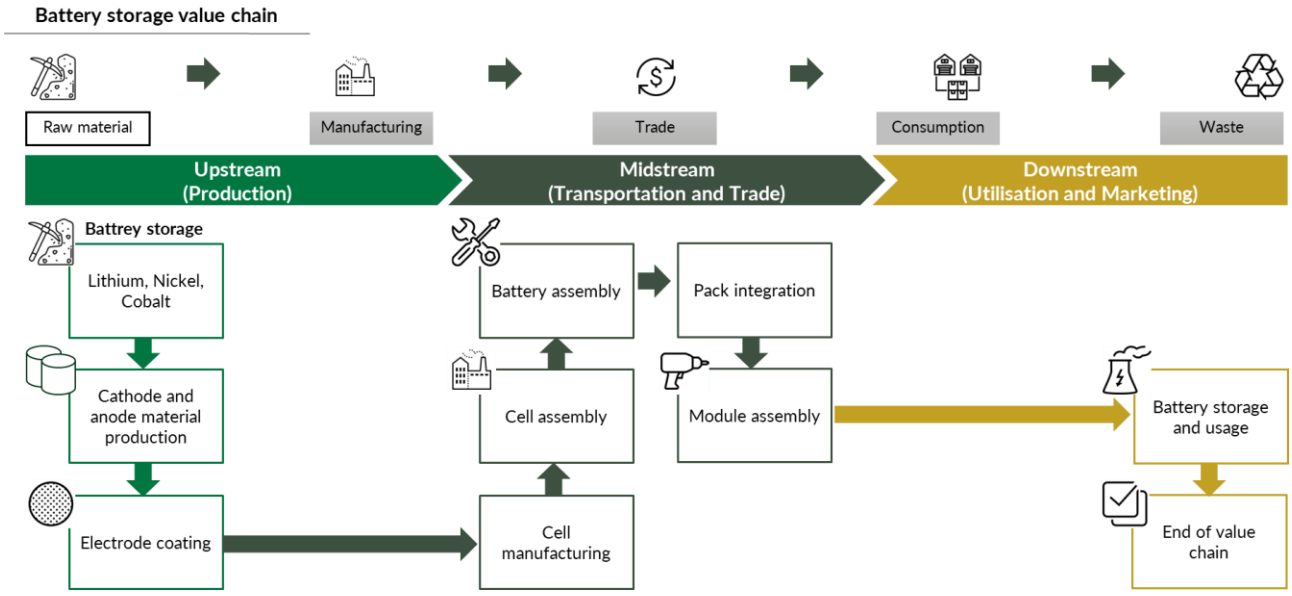


Figure 52: Battery storage value chain[212]

[211] Africa International Advisors (AIA) Analysis
[212] Eskom Integrated Report (2023)

The "Hydrogen Valley" project, connecting Mogale to Richards Bay, presents opportunities for Limpopo where the province could potentially contribute to the fuel cell value chain (Figure 53):

- **Host Hydrogen Production Facilities:** Renewable energy sources like solar or wind could be used to produce green hydrogen, a clean fuel alternative.
- **Develop Hydrogen Infrastructure:** Building refuelling stations and supporting hydrogen-powered transportation could create a hydrogen ecosystem within the province.

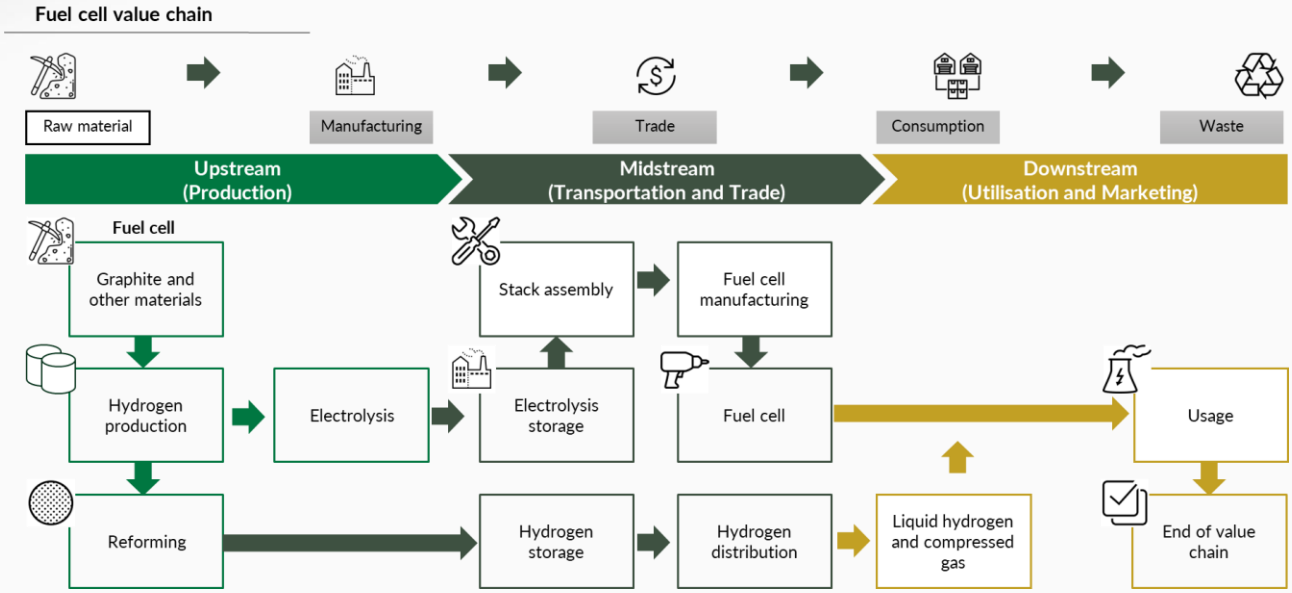


Figure 53: Fuel cell value chain[213]

[213] Africa International Advisors (AIA) Analysis

4 PROVINCIAL ENERGY NEEDS ASSESSMENT

4.1 Introduction

The Limpopo Provincial Energy Needs Assessment and Intervention Strategy, together with the Provincial Norms and Standards forms part of the province's Renewable Energy Strategy. This section provides a comprehensive analysis of the province's current energy landscape and explores potential pathways for a secure and sustainable future. Additionally, the section details the methodologies used to assess Limpopo's energy demand, including firewood consumption, alongside its energy supply.

The report presents two scenarios:

- **Scenario 1:** This scenario is unfolding in response to the ongoing challenges of an unreliable national power grid and frequent load shedding. The province is strategically shifting away from reliance on the national electricity provider, Eskom, and embracing a diversified energy approach. This includes harnessing abundant solar resources through extensive infrastructure, investing in advanced energy storage technologies, and exploring the potential of biomass energy from organic waste.

- **Scenario 2:** Scenario 2 focuses on carbon emission reduction. The province aims to incorporate renewable energy sources into its existing energy mix, comprising utility-scale power plants, commercial and industrial sectors, and residential consumption. This strategic shift towards cleaner energy sources is expected to impact Limpopo's carbon grid emission factor.

There is a complex interplay of factors that need to be considered when developing a renewable energy strategy for the province. Figure 54 highlights three main areas for analysis: what the province is trying to solve for, the complexities involved, and the desired outcomes.

What the province is trying to solve for includes challenges like high unemployment, poverty, and significant inequalities. Overdependence on the grid and high municipal debt are also areas demanding solutions. Additionally, underdeveloped industrial sectors and insufficient investment in high-potential sectors are economic hurdles that need to be addressed.

The complexities involved in the transition to renewable energy sources are multifaceted. Potential job losses caused by the shift away from fossil fuels, underdeveloped industrial capacity, and high population growth pushing up energy demand are all significant challenges. Collaboration between different stakeholders is crucial for successful implementation, but hurdles exist such as the lack of land-use agreements critical for solar (Photovoltaics) PV installations. The electricity capacity shortage and vulnerabilities in the energy value chain further complicate the transition.

The desired outcomes of the renewable energy strategy focus on economic development, energy security and just energy transition. It involves the creation of new jobs across the renewable energy value chain and fostering economic development. The strategy also aims to bridge the gap between Eskom supply and municipal demand for energy. Improved energy security will come from a diversified energy mix that reduces reliance on fossil fuels and fosters a sustainable energy future with just energy transition aiming to drive towards environmental friendliness whilst ensuring all those involved in the transition are taken into consideration.

WHAT ARE WE TRYING TO SOLVE FOR?	WHAT ARE THE COMPLEXITIES?	WHAT ARE WE TRYING TO ACHIEVE?
• High unemployment, poverty and significant inequalities • Overdepedence on Eskom and high Muncipal debt • Underdeveloped industrial base and insufficient investment in high-potential sectors • Reliance on fossil energy sources with most located outside Limpopo • Electricity capacity shortage – loadshedding • Vulnerabilities in the energy value chain affecting economic activities • Lower economic growth conditions • Vandalism and cable theft	• Difficult to transition from fossils • Climate change considerations • Potential job losses caused by the transition • High population growth pushing up demand for energy and this outpacing current supply growth • Collaboration between different stakeholders is lacking – no land use agreements in place which are critical to Solar PV installations • Misalignment of policies at National and Provincial level • Insufficient skills to carry out manufacturing and maintenance of component across the renewable energy value chain	**Economic Development** 1. Creation of new jobs across the renewable energy value chain 2. Due to improved technology, renewables are becoming more cost effective – **affordability** 3. SMMEs, youth groups, women groups, stokvels can play a part, apart from government by pooling funds geared towards Solar PV installations and enjoy economies of scale 4. Municipalities will be able to earn from tariffs charged for storage of surplus power **Energy Security** 1. Renewables will bridge the gap between Eskom Supply and Municipal demand 2. *Role of Municipalities will change:* – Not only will they distribute power but also own the storage. They will buy from IPPs and Eskom generation as well as surplus from embedded generation. Storage capacity will be key to meet demand needs during off-peak solar and wind intensity 3. *Role of Province will be critical:* – Allocate budgets to renewables and establish relevant Public-Private Partnerships (PPPs) – Put policies and structures in place to attract investments into the Renewable energy economy hence ensuring **sustainability** of supply – Ensure land use agreements are in place to facilitate successful project execution – Create awareness and increase inclusion of various stakeholders through community enagements and involving other parties such as the private sector, academics etc. **Just Energy Transition** 1. Renewables are environmentally friendly – reduced carbon emissions 2. The renewable energy strategy will contribute to skills devopment to support the ecosystem 3. Renewables will be **accessible** to community-wide members as well in addition to the public and private sector

Figure 54: Understanding why the strategy is important

4.2 Methodology

4.2.1 Determination of Demand

To model Limpopo's electricity demand, two distinct approaches were used: a linear regression model and the South African National Energy Development Institute (SANEDI) model[214] (Figure 55). The linear regression model utilizes a statistical method to forecast electricity demand based on historical data and its relationship with influential factors. These factors include provincial Gross Domestic Product (GDP), population and CPI (Consumer Price Index) for electricity. This approach allows for a relatively straightforward and interpretable understanding of how these factors affect electricity demand.

The SANEDI model incorporates a more complex methodology. This model focuses on a sectoral approach to forecast demand. This involves considering electricity consumption by various sectors, such as agriculture, mining, manufacturing, commerce, residential areas, traction, and international factors like exports. This sectoral approach offers a more granular understanding of how different parts of the economy contribute to electricity demand.

[214] ESRG Single Node Hourly Demand Model. University of Cape Town

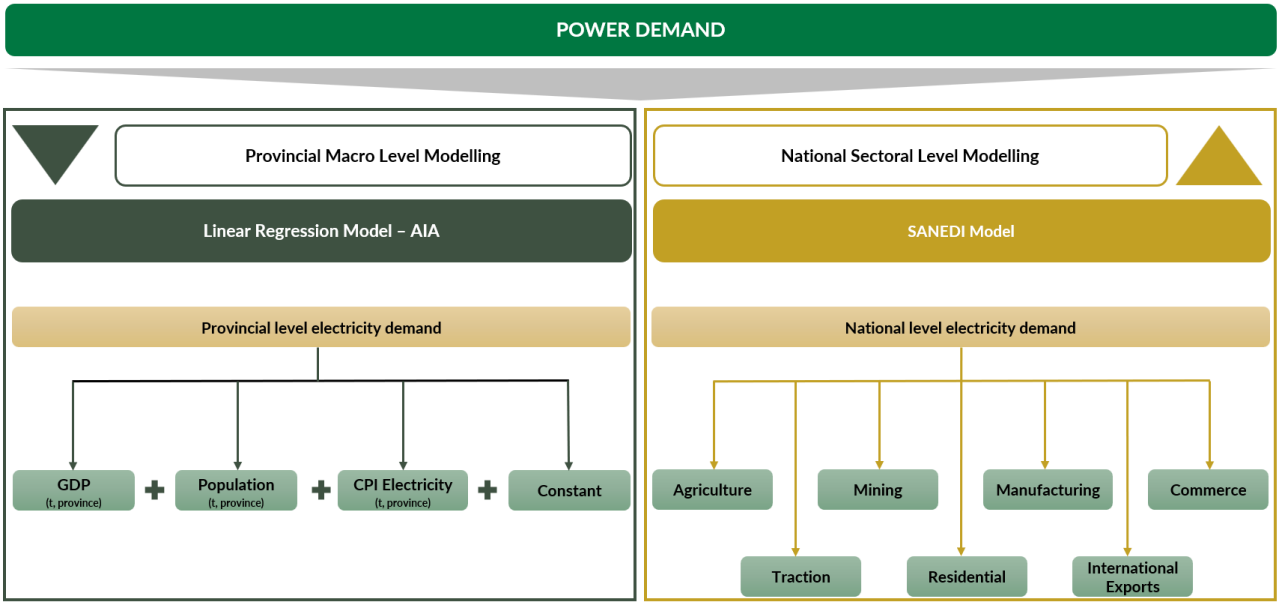


Figure 55: Power demand models

A linear regression model that factors in provincial GDP and electrification rate was used to understand the firewood usage in Limpopo (Figure 56). The model used economic growth and access to electricity as proxies for firewood dependence. The analysis reveals an inverse relationship between provincial GDPs per capita and electrification rate, on the one hand, and firewood demand on the other. This suggests that rising household disposable income levels, as indicated by increasing GDP per capita, and improved access to electricity, reflected by a higher electrification rate, both contribute to a decrease in firewood consumption. In other words, as households become wealthier and gain access to electricity, their reliance on firewood diminishes[215].

This approach provides a valuable estimate, but it acknowledges limitations such as unaccounted variables that may influence firewood usage in the future.

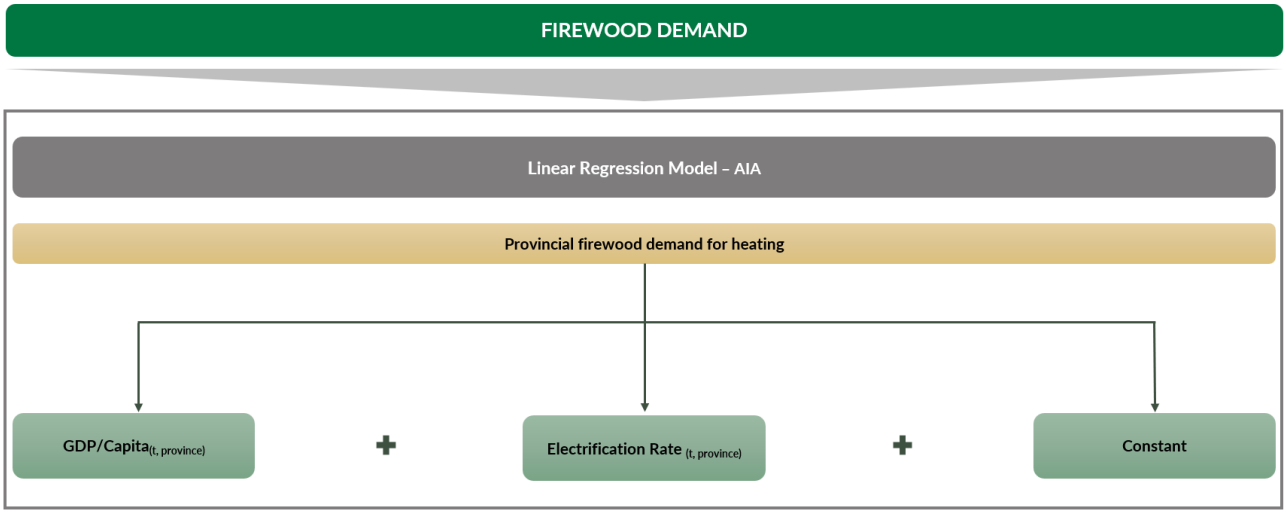


Figure 56: Power demand model for firewood

[215] AIA analysis

4.3.2 Market Structure Shift

The power generation landscape in South Africa is undergoing a significant shift, moving away from a centralized model dominated by Eskom towards a decentralized approach (Figure 57)[216]. This change is driven by two key factors: the unbundling of Eskom and regulatory changes by the National Energy Regulator of South Africa (NERSA).

One crucial element is NERSA's introduction of a 100MW cap on new generation capacity. This creates an opportunity for alternative sources to play a role. The unbundling of Eskom further accelerates this decentralization trend. By separating generation, transmission, and distribution functions, it empowers municipalities and private entities to generate their own electricity. This reduces their dependence on Eskom's centralized grid and allows for a more diversified energy mix.

The overall trend points towards a decentralized future for Limpopo's power supply, with IPPs and embedded generation playing a more significant role in meeting the province's energy needs.

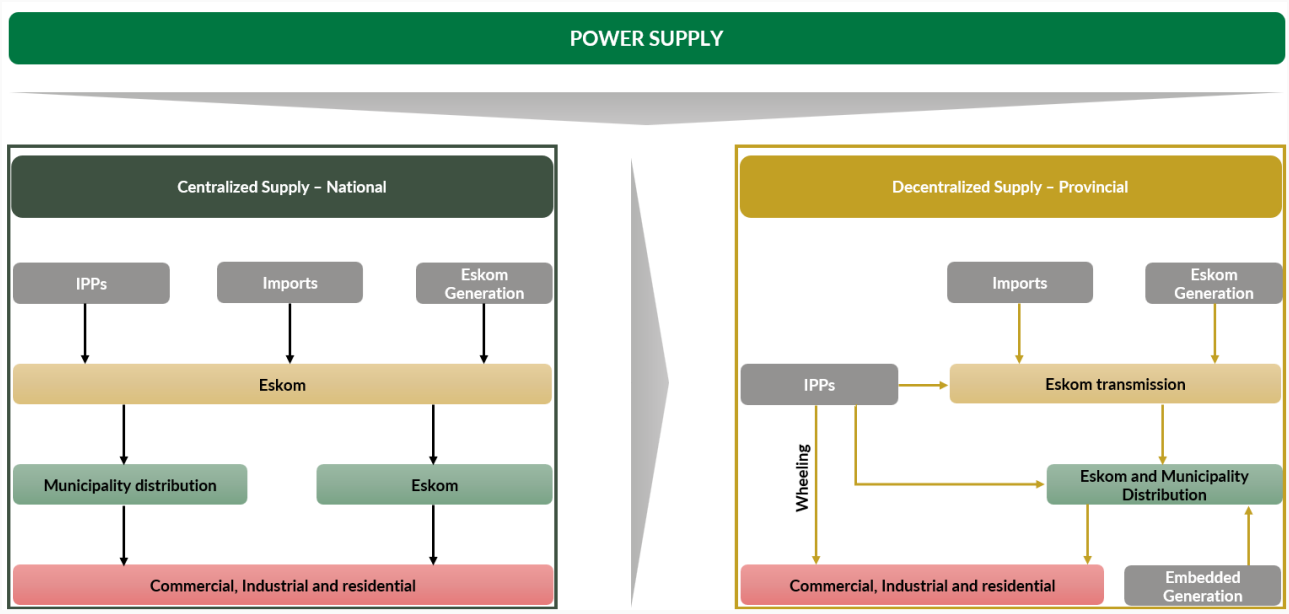


Figure 57: Power supply

A critical aspect of strategy lies in the coordinated effort of various stakeholders (Figure 58). The Provincial Government establishes frameworks that guide Integrated Development Plans (IDPs) and Municipal energy plans, which are responsible for the development of renewable energy infrastructure. Municipalities oversee local electricity distribution and potentially engage in power purchase agreements with Independent Power Producers (IPPs) under the new Electricity Regulation Amendment Bill. The National Transmission Company of South Africa (NTCSA) maintains grid stability and facilitates fair access, while NERSA governs market conduct, pricing, and grid connections. This collaborative approach empowers IPPs to contribute to the grid with renewable energy sources, ultimately fostering a more diverse and secure energy future for consumers who can now participate as prosumers[217].

[216] AIA analysis
[217] Electricity Regulation Amendment Bill (2023)

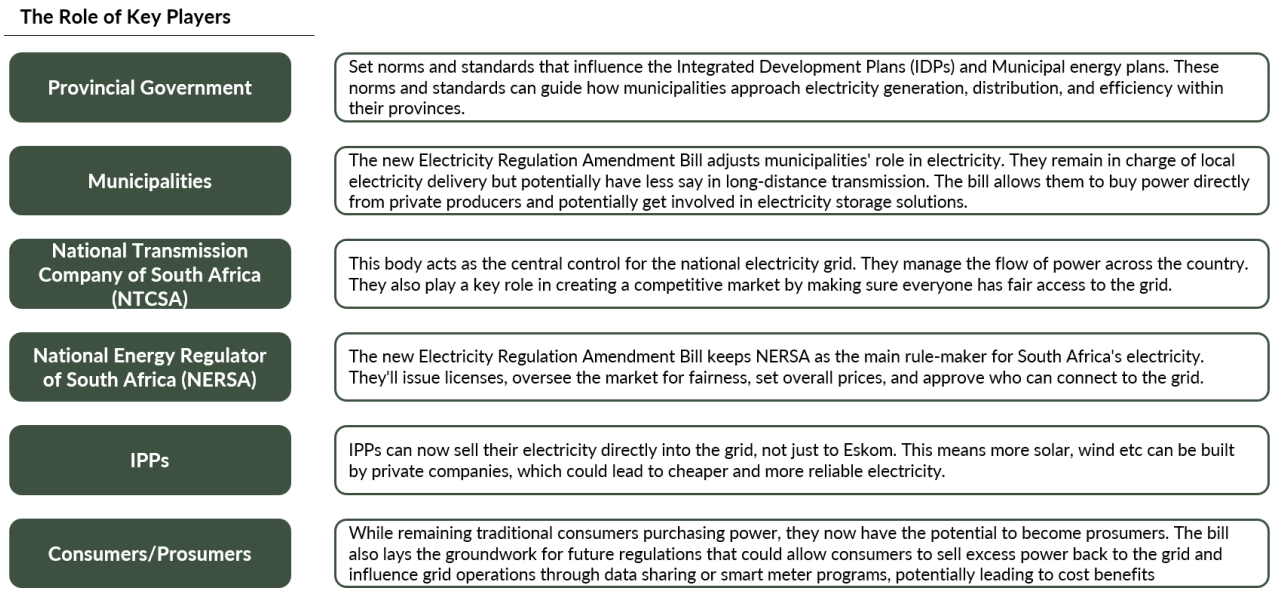


Figure 58: Role of province, municipalities and IPP's

In the previous market structure Eskom Holdings completely dominated the electricity market (Figure 59). Eskom held the roles of generation, transmission, and distribution and IPPs could only sell electricity to Eskom, which would then distribute it to municipalities and end users. This structure limited competition in the electricity market.

In the current market structure, Eskom Holdings remains a dominant player, but its functionalities have been separated where Eskom now focuses solely on electricity generation. A key change is the independence of the Market Operator and System Operator functions, which was previously under Eskom. This separation indicates a move towards a more open market. In addition, the National Transmission System Operator (NTSCA), previously a subsidiary of Eskom, is now operating independently[218].

The envisioned future market structure presents a significant shift. Eskom Holdings will remain a major participant, but its functionalities will be further divided. Electricity generation will become Eskom's sole responsibility. A critical change lies in the establishment of an independent Transmission System Operator (TSO). Establishing a separate and independent transmission company offers several benefits. It allows for easier regulation by separating the functions of generation and transmission creating a more transparent and accountable system. The independent company can establish predictable revenue streams making it a more attractive investment opportunity[219].

Another key aspect of the future structure is that IPPs would likely be able to participate directly, selling electricity and potentially fostering a more competitive environment. The final leg of electricity delivery would presumably fall under Eskom Distribution and Municipal Distribution entities, working together to ensure end users receive their power.

The envisioned future market structure paves the way for a more open and competitive electricity sector. The separation of Eskom's functionalities, the establishment of independent operators, and the potential for IPP participation are all steps towards a more dynamic and efficient electricity market.

[218] Power Futures Lab, University of Cape Town
[219] Electricity Amendment Bill (2023)

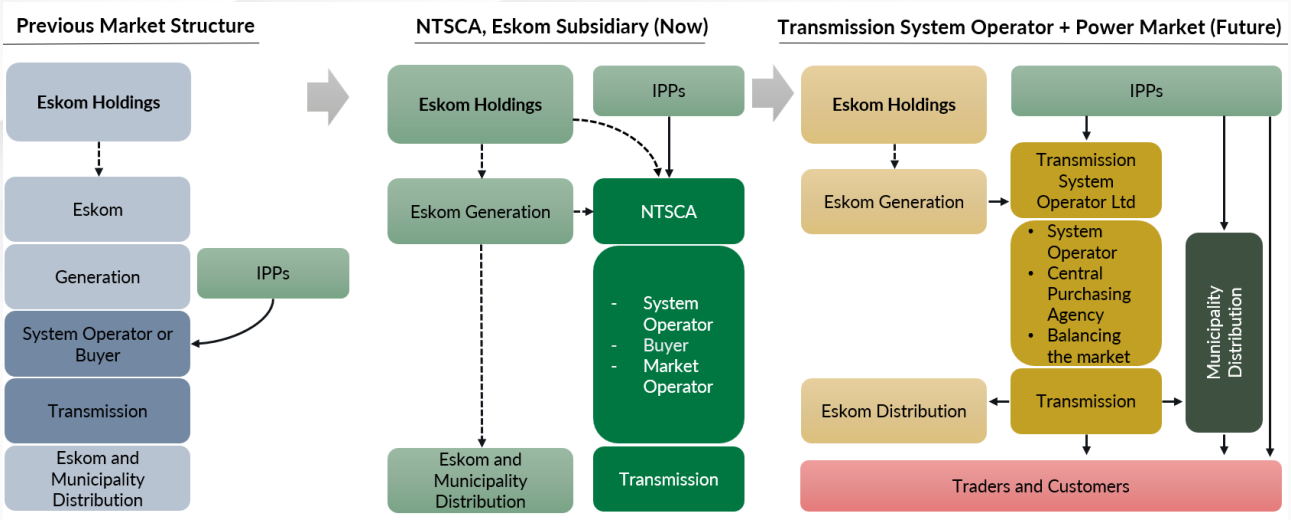


Figure 59: Past, present and future market structure

4.3.3 Concept of Wheeling

As per Eskom's definition, wheeling is the process of delivering electricity from a generator to a customer located in a different area by utilizing existing transmission and distribution networks. Figure 60 illustrates a solar power plant acting as the generator and a customer (i.e. commercial, industrial, or residential) as the load customer. The electricity travels through Eskom's transmission network and potentially a municipal distribution network to reach the customer. Importantly, the exact electrons generated by the solar power plant won't necessarily be the same electrons that reach the customer. Wheeling works through a financial transaction system that balances the electricity injected into the grid with the power withdrawn by the customer. There are also fees associated with using the transmission and distribution lines. Wheeling allows for privately produced electricity to be distributed across the grid to customers, fostering a competitive marketplace[220].

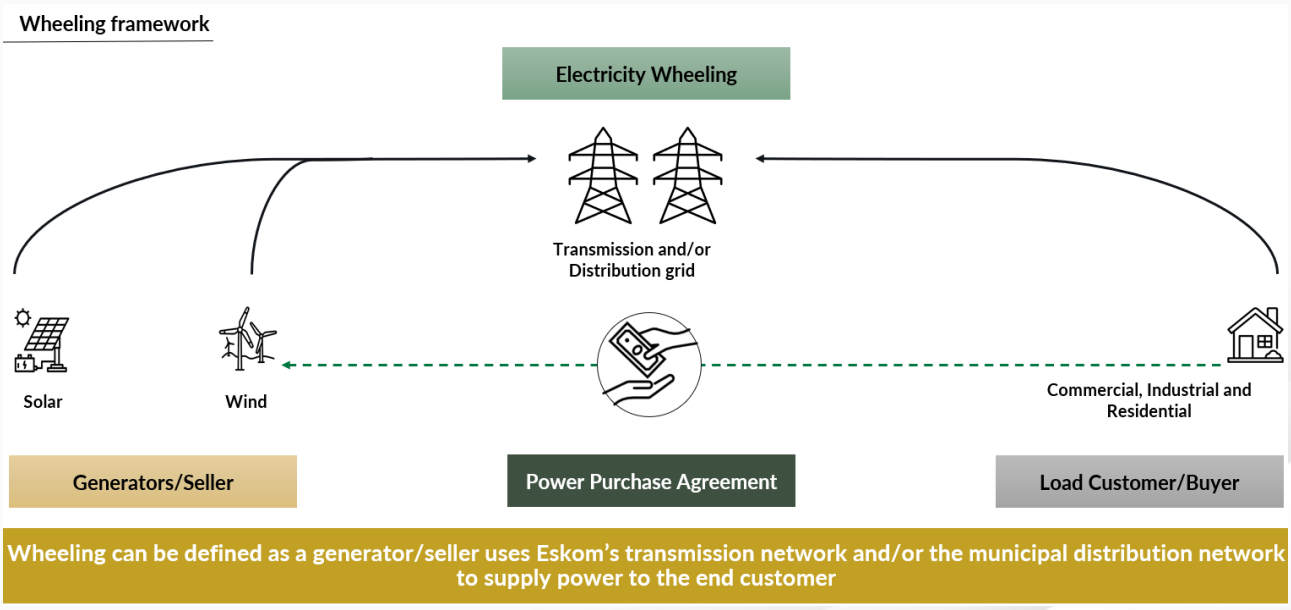


Figure 60: Wheeling framework

[220] Eskom wheeling factsheet

The South African Local Government Association (SALGA) outlines three potential scenarios for wheeling electricity based on the location of the generator and the off taker [221] (Figure 61):

- **Scenario 1: Wheeling from an Eskom-connected generator to a municipal off-taker**. In this scenario, the off taker is situated within the municipality's network while Generator is located outside the municipality network i.e. wheeled energy travels on both the Eskom and Municipality network.

- **Scenario 2: Wheeling from a municipal-connected generator to a municipal off-taker.** In this scenario, both the Generator and the off taker are situated within the same Municipality network i.e. wheeled energy only travels on the Municipality network.

- **Scenario 3: Wheeling from a municipal-connected generator to an Eskom-connected off-taker outside the municipality**. Here, the Generator is within the Municipality network, but off taker is outside this network either in another Municipality or Eskom network.

Considering the available grid within Limpopo, scenario 2 is the most favourable option for municipalities within the province, followed by scenario 1.

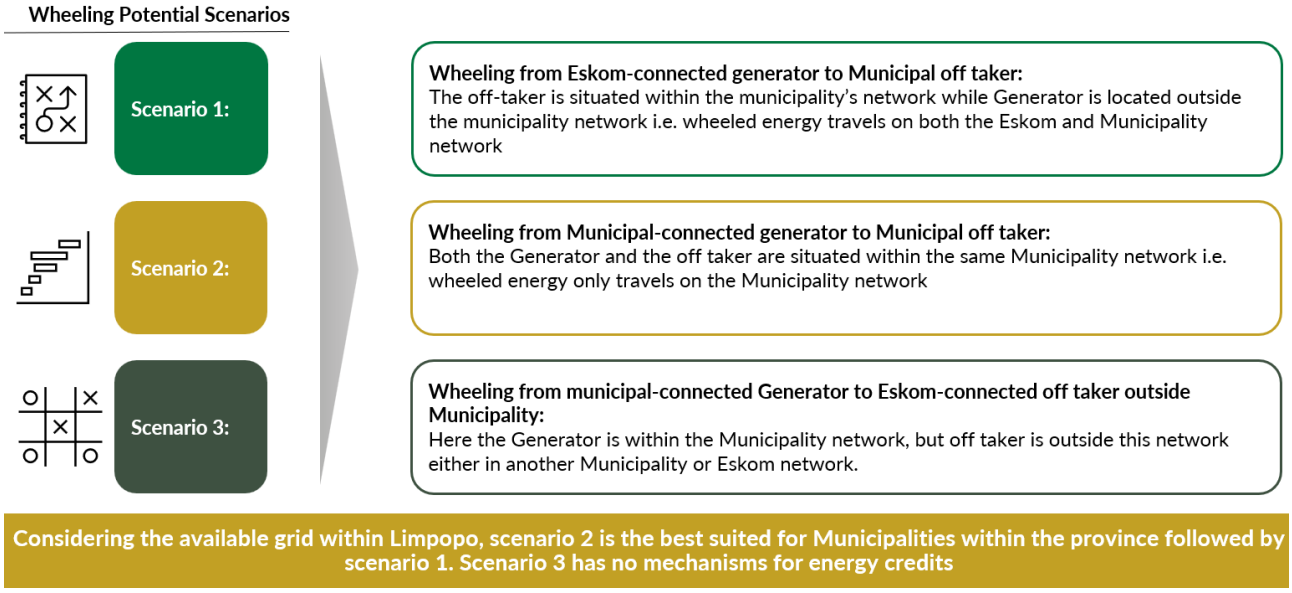


Figure 61: Potential wheeling scenarios

Following the selection of the scenarios mentioned above, municipalities will need to determine charges associated with wheeling based on three potential Wheeling Billing Frameworks[222] (Figure 62).

- **Framework 1:** This straightforward approach adds a per-unit "Use of System Charge" to the Eskom "Energy purchase price". These are the normal NERSA approved tariffs charged by Municipalities.

- **Framework 2:** The "Use of System Charge" is determined as the difference between the "Municipality Energy Tariff" and the "Energy purchase price". This is a per unit charge for wheeled energy. The charge covers all approved fixed charges, energy charges including subsidies and regulated surpluses as well as demand charges.

[221] SALGA Status of Wheeling Report, July 2023
[222] SALGA Status of Wheeling Report

- **Framework 3:** This framework introduces the concept of the "Wheeling Credit". Normal "Municipal Energy Tariffs" are charged for all energy supplied to the off taker. The off taker is then credited for all wheeled energy received excluding losses at Eskom's wholesale electricity pricing structure.

Framework 2 and 3 yield similar results in that there is zero impact on municipal revenues. The utilization of a wheeling credit as per method 3 is ideal, as it utilizes NERSA approved tariffs hence no need for additional tariff approvals.

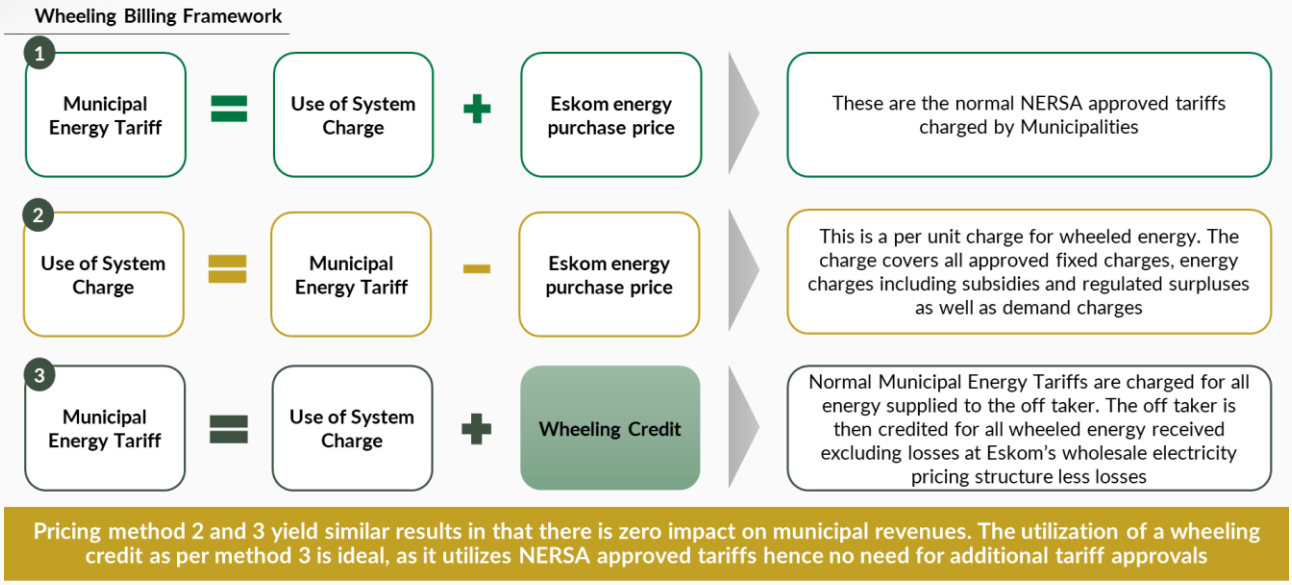


Figure 62: Wheeling billing framework

Figure 63 outlines a potential revenue stream for municipalities through wheeling and storage tariffs[223]. In the scenario depicted, a municipality acts as the wheeling intermediary. It purchases electricity from a generator and transmits it via its distribution network to a customer. The municipality would then collect a "wheeling tariff" from the customer for this service.

In addition, municipalities could store excess electrons in batteries. This stored electricity could then be sold back to the grid during peak demand periods, potentially at a higher price. The municipality would receive a "storage tariff" for this service. By implementing these strategies, municipalities can generate additional revenue to complement their existing revenue base.

[223] SALGA Status of Wheeling Report

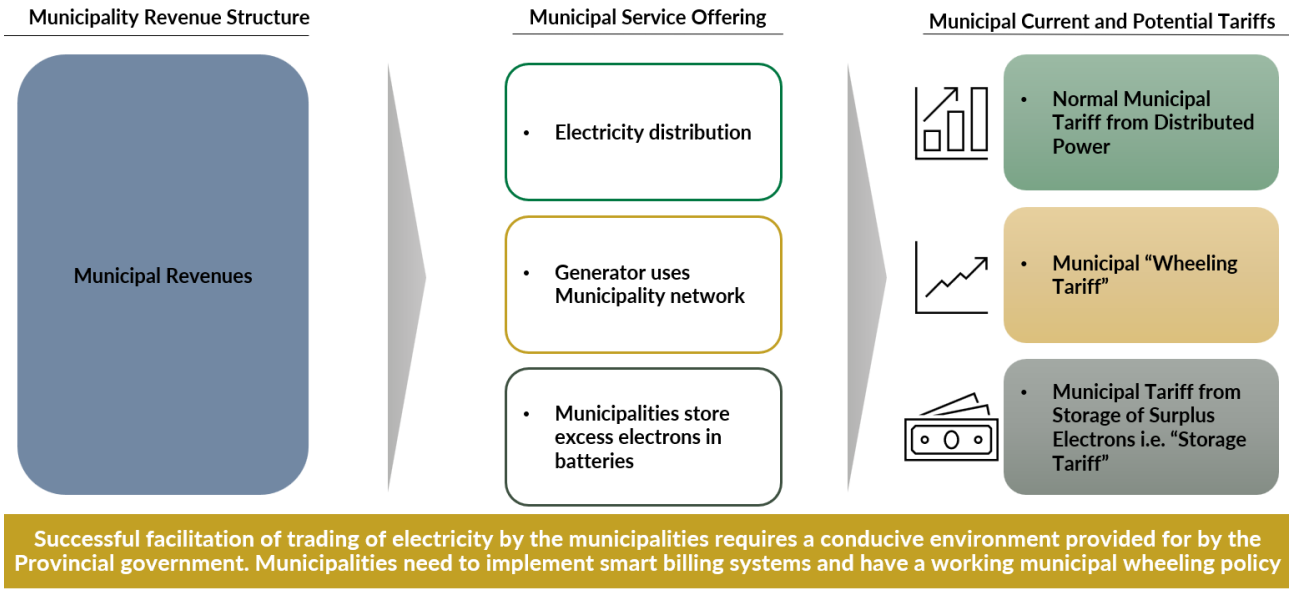


Figure 63: Municipality revenue structure

South Africa's wheeling ecosystem thrives on the collaboration of diverse stakeholders. The Provincial Government lays the groundwork through policy frameworks that guide energy plans, fostering the development of renewable energy sources that feed into the wheeling system. Municipalities, can now directly purchase electricity and potentially participate in storage solutions, further enhancing their role in delivering wheeled power through their distribution networks. NERSA, the national energy regulator, ensures fair play by establishing licensing, pricing, and grid connection protocols. The NTCSA, acting as the grid's central conductor, manages electricity flow across the country, integrating wheeled power seamlessly while the role of IPPs involve supplying renewable energy directly to the grid, expanding the resource pool for wheeling. Ultimately, consumers benefit from a potentially more competitive market with wider access to diverse, potentially lower-cost electricity delivered via wheeling.

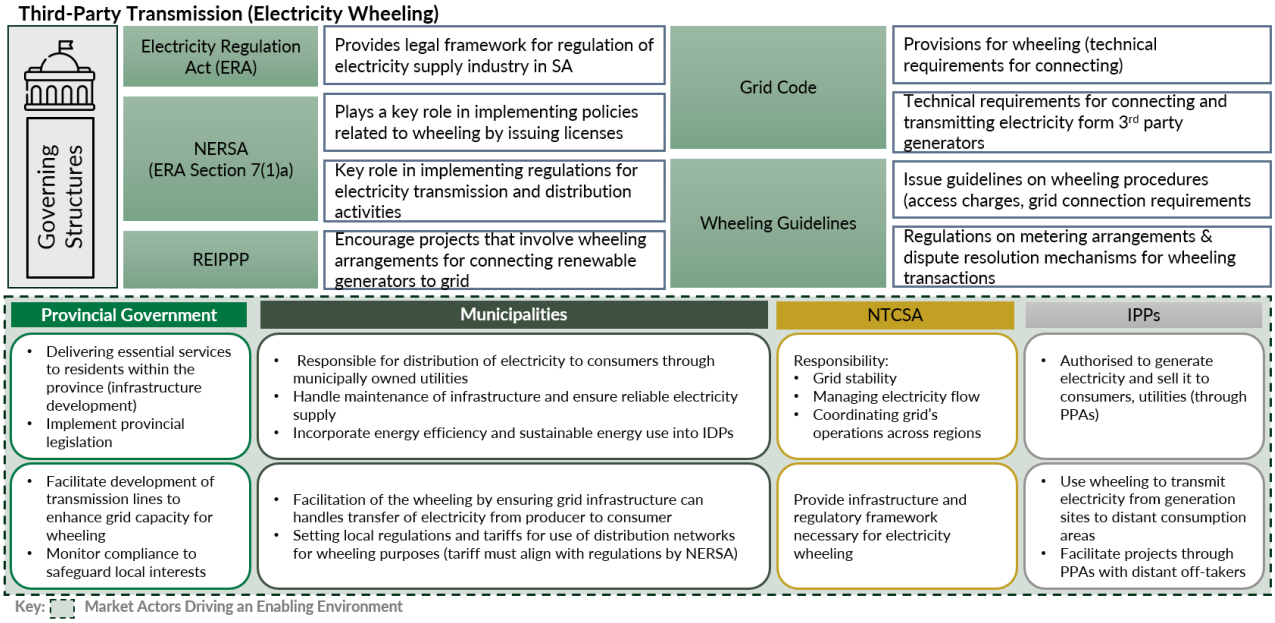


Figure 64: The role of key players regarding wheeling

Limpopo municipalities show a mixed picture regarding licensing for potential projects (Figure 65). Only 13 out of 22 municipalities have licenses, with none in the entire Sekhukhune district (comprising 4 municipalities). The remaining nine municipalities would require assistance in attaining their licences. Lepelle-Nkumpi, Musina, Makhado, Mogalakwena, Polokwane and Ba-Phalaborwa are identified as pilot sites for wheeling initiatives, however, their eligibility would depend on verifying outstanding debt to Eskom.

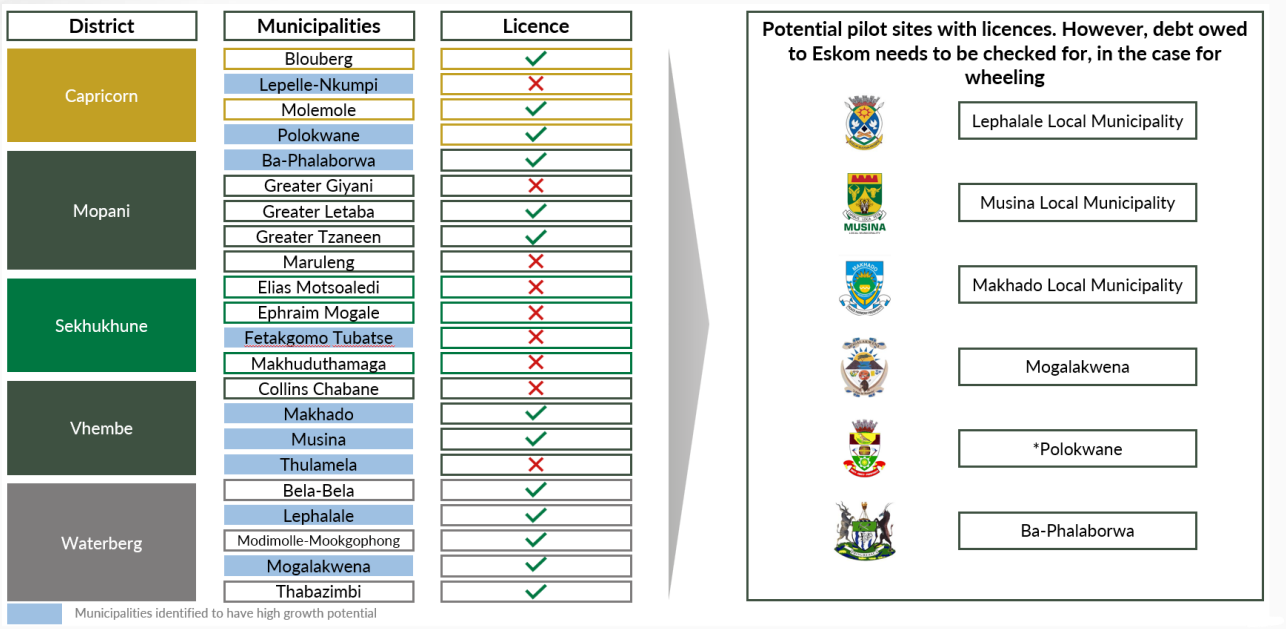


Figure 65 Municipalities with the potential for wheeling

4.3.4 Embedded Generation and Storage

A key consideration when integrating renewable energy sources is their inherent intermittent nature (Figure 66). Embedded generation, where electricity is produced on-site at a building or facility, is a prime example. Solar panels generate electricity directly proportional to sunlight availability. While surplus power can be fed back to the grid, embedded generation systems may not always fully meet electricity demands, particularly during peak usage times or periods with minimal sunlight. Therefore, a reliable grid connection remains crucial to supplement embedded generation and ensure uninterrupted power supply. This is depicted in the figure below where the grid acts as a backup source during nighttime hours. Embedded generation with renewable sources offers advantages in reducing reliance on the main grid but requires careful consideration of intermittent nature of renewables and the continued importance of a robust grid infrastructure.

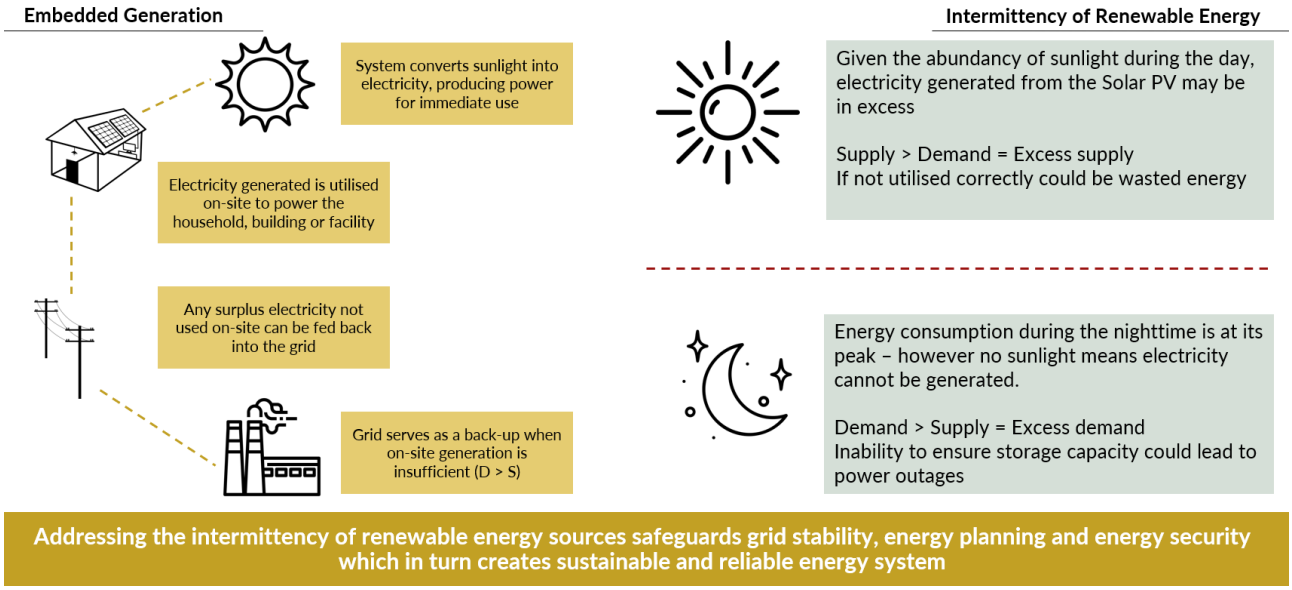


Figure 66: Embedded generation and the intermittency of renewable energy

The concept of arbitrage, exploiting price discrepancies to generate profit, can be applied within the electricity market through two primary mechanisms: storage and trading arbitrage (Figure 67).

- Storage arbitrage capitalizes on price fluctuations throughout the day. Electricity can be purchased during low-cost, off-peak periods and stored in battery systems. This stored power can then be sold back to the grid during high-cost, peak hours. The "economics of storage" being driven by scale, suggests that larger battery capacities offer greater cost-effectiveness through economies of scale.

- Trading arbitrage leverages geographical or temporal price variations. Electricity can be purchased from a location or market with a lower price (i.e. during off-peak hours) and sold to allocation at a higher price (i.e. during peak hours).

The possibility of local governments acting as "electricity trade hubs" is also a possibility. This suggests a potential future role for municipalities in facilitating these arbitrage opportunities, potentially creating additional revenue streams, and fostering market efficiency.

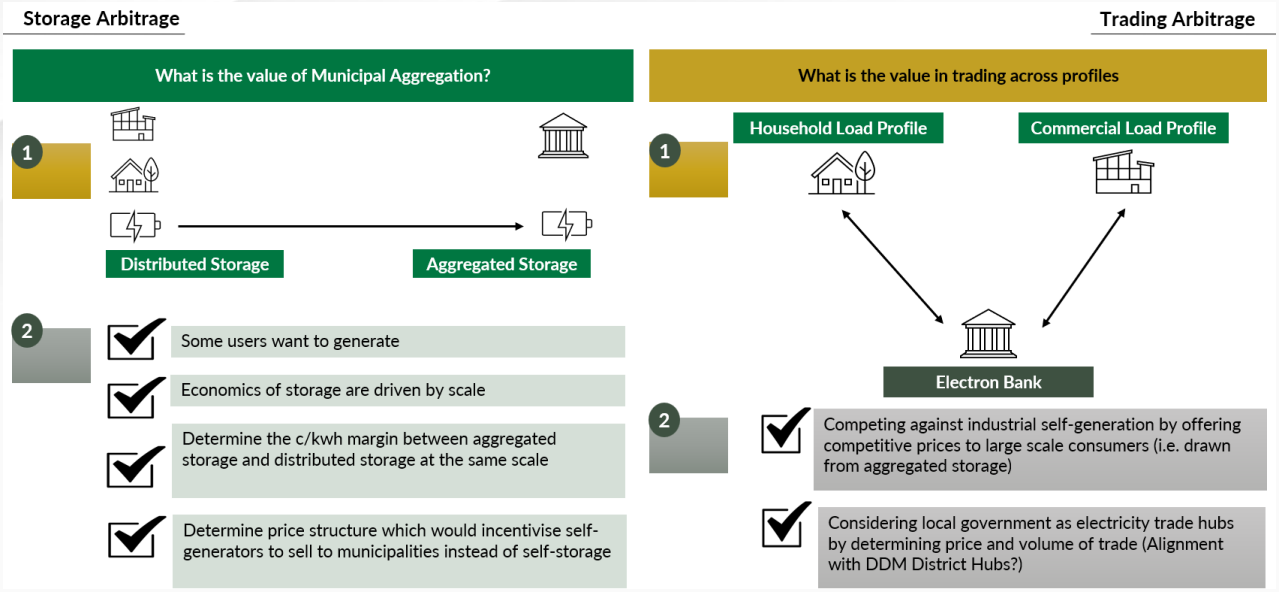


Figure 67: Storage and trading arbitrage

Municipalities and generators (residential, commercial, and industrial) have a role to play in the storage and trading of electrons as well as the generation and transmission of electrons (Figure 68).

- **Storage and Trading:** Municipalities are envisioned as playing a central role. They can purchase excess electricity, from renewable generators, during periods of low demand. This electricity can then be stored in batteries for later use. When demand is high and prices are at a premium, the stored electrons can be released back into the grid for trading, potentially generating additional revenue for municipalities.

- **Generation and Transmission:** A stable and reliable grid network is crucial for achieving a sustainable energy future. To effectively manage the surplus electricity generated from embedded renewable sources by residential, commercial, and industrial players, robust storage solutions are essential. Excess energy produced during the day could be efficiently channelled to municipal battery storage systems.

This framework aims to leverage excess renewable energy generation and create an opportunity for municipalities to participate in the electricity market through storage, electron trading and generation if need required.

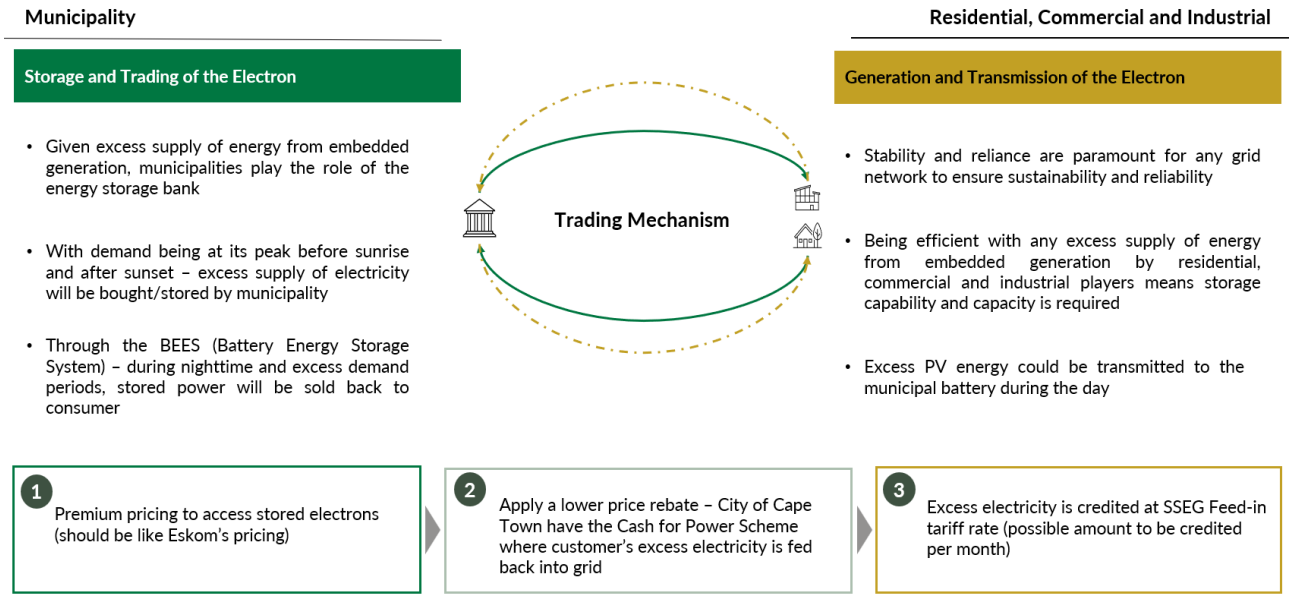


Figure 68: Overview of the electron trading mechanism between municipalities and generators

A key element of empowering municipalities is in their potential to act as energy storage hubs. This mirrors how banks leverage economies of scale to offer financial services. While solar panels are becoming more prevalent, battery storage, crucial for balancing grid load with solar intermittency, lags due to higher costs. Municipal aggregation offers a solution. Residents and businesses could significantly reduce storage costs by outsourcing to a municipal battery bank, essentially a shared storage facility. The municipality would manage the system, setting trading rates to optimize usage and costs. This approach offers significant benefits such as:

- Lower energy costs for residents and businesses through bulk purchasing of batteries
- Increased access to renewable energy for those who can't afford individual storage
- Reduced strain on the power grid

Additionally, a successful program could attract new businesses and create jobs in the clean energy sector, while also promoting energy decentralization by offering clean power to remote areas currently lacking grid access. An example of such a program is the Small-Scale Embedded Generation (SSEG) Tariff in the City of Cape Town.

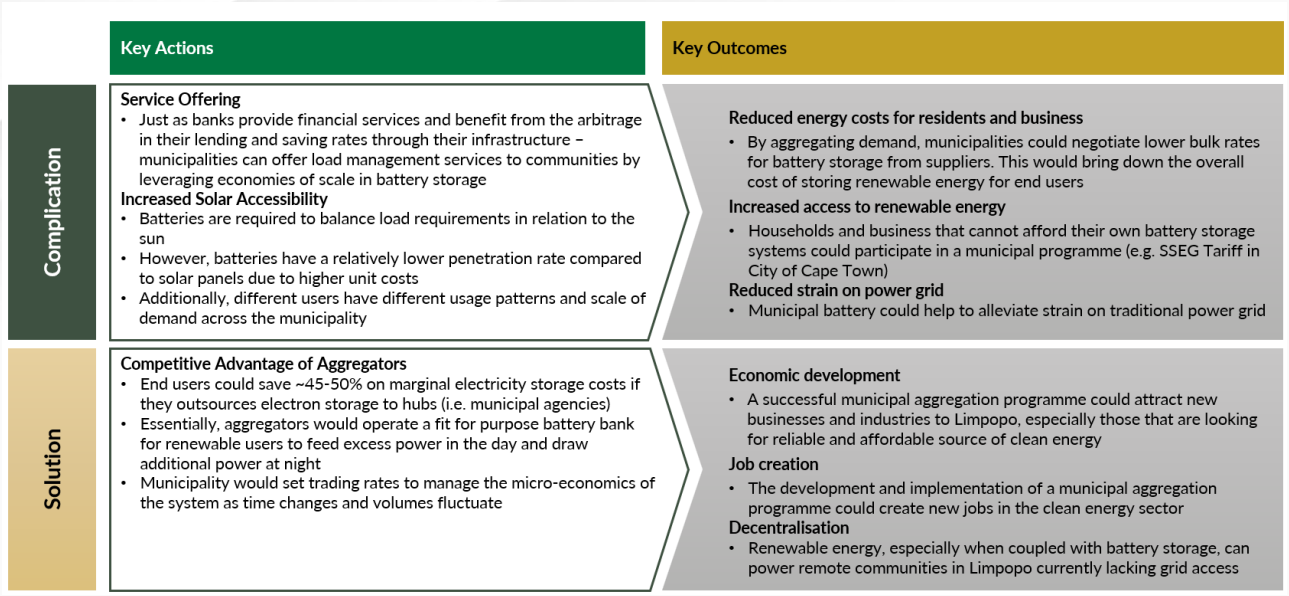


Figure 69: Municipalities role as an electron bank

A successful embedded generation and battery storage ecosystem necessitates collaboration between various stakeholders. The key market players to drive an enabling environment include provincial government, municipalities with the assistance of prosumers.

Provincial governments play a critical role of creating an enabling environment through establishing frameworks and regional energy plans that incorporate embedded generation, a market that supports wheeling and trading of electricity while ensuring coordinated implementation across municipalities. Furthermore, they are responsible for delivering essential services, including infrastructure development, which underpins the successful integration of these distributed energy resources. Municipalities are responsible for electricity distribution to consumers, oversee the integration of embedded generation into the grid by handling grid connection approvals and implementing net metering policies. Additionally, they play a vital role in ensuring safety and technical compliance through permitting and regulation.

On the other hand, Prosumers, those who generate their own electricity and can feed excess power back into the grid, become key actors in driving the adoption of renewable energy technologies and promoting environmental sustainability. Their contributions extend to grid stability and cost savings, as their generation capacity reduces reliance on the traditional grid and minimizes transmission losses. Storage enables prosumers to maintain reliable energy access during outages and potentially generate revenue by selling excess energy back to the grid.

An important component is the compliance with regulations set by NERSA, such as obtaining necessary licenses. This multi-stakeholder approach, where policymakers, regulators, utilities, distributors, and prosumers work together, is paramount to maximizing the potential of embedded generation and battery storage.

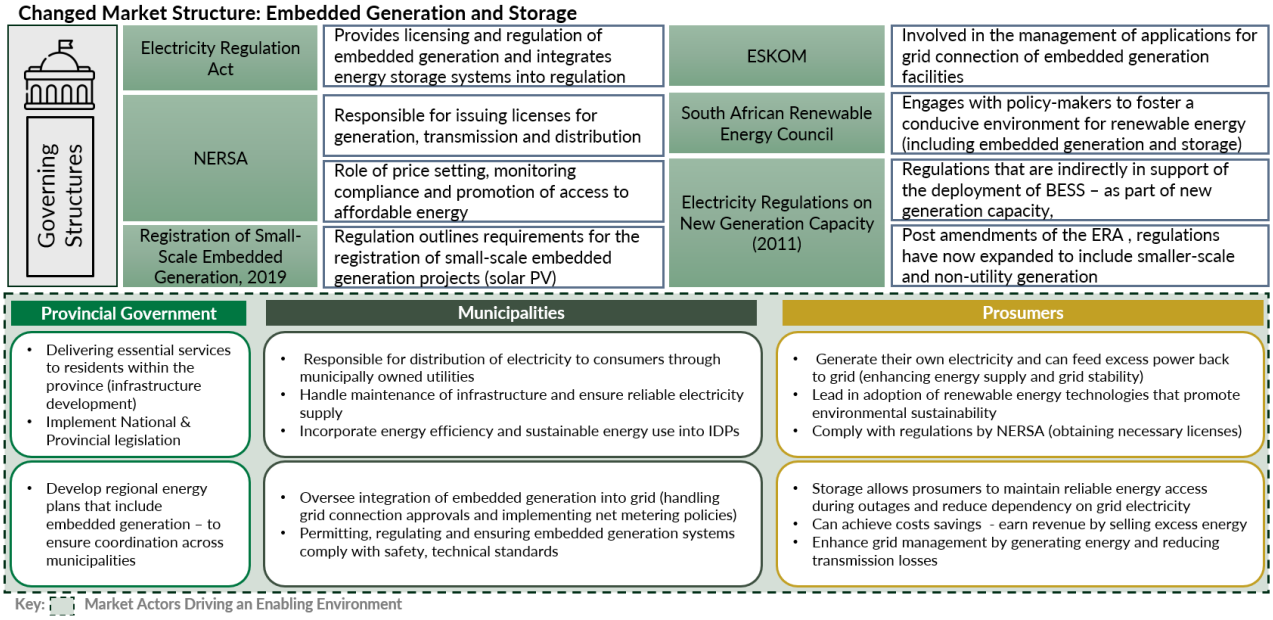


Figure 70: Key players required to enable generation and storage

4.3 Provincial Energy Needs Assessment and Intervention Strategy

4.4.1 Assumptions

Several factors were considered for modelling renewable energy scenarios in Limpopo (Figure 71). While electrification rates are rising in Limpopo, residents in traditional settlements still rely heavily on firewood. Economic growth, as measured by GDP, can impact future energy consumption patterns. Inflation is another driver that impacts energy efficiency, potentially leading to a reduction in overall energy demand. Another key constraint identified is the limited grid capacity in certain areas of South Africa. However, Limpopo's has 3360 MW of grid capacity available, according to Generation Connection Capacity Assessment (GCCA) 2025 data. However, the ability of the central government to contract for the required capacity to connect new renewable energy sources is a variable that needs to be considered. In addition, there has been a rise in unplanned outages due to the performance of Eskom's coal fleet coupled with a steady reduction in the EAF. This has resulted in looking into extending the life span of the coal fleet. Other provinces are exploring the potential for gas-to-power options. The possibility of nuclear power being introduced by 2035 and the availability of regional hydro resources are also considerations. While the IRP (2023) proposes the inclusion of 2.5 GW of nuclear capacity by 2035, large hydro sources have faced delays, adding uncertainty to this potential source of clean energy.

Considerations for renewables roll-out

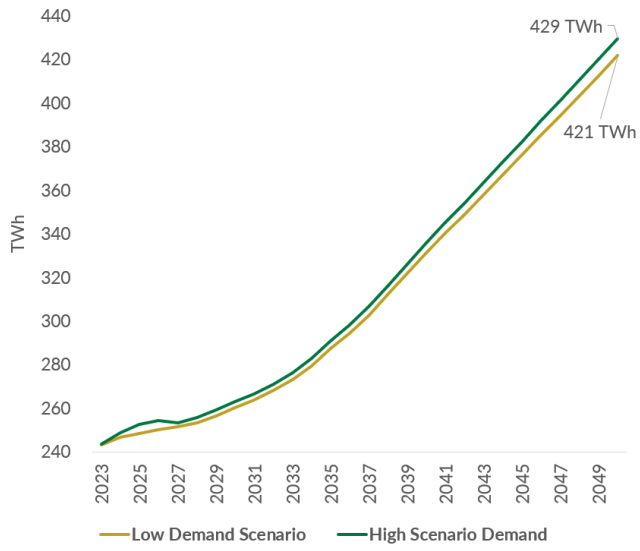
Factors	What has happened	Variables with Considerations	
Demand	• Limpopo has a high electrification rate, but traditional and informal settlements continue to use firewood • Services sector leading the South African economy • Inflation has driven energy efficiency and a reduction in the industrial base	• Economic growth • The economy's structure • Electric vehicle penetration • How will the economy react to restoration of demand security?	• GDP • Embedded generation • EV penetration
Decommissioning and performance of Eskom's coal fleet	• Rapid rise in unplanned outages • Steady reduction in EAF over time • Increasing push to extend life of coal fleet	• Ability to reverse increase in unplanned outages • Feasibility of coal station life extensions	• EAF of coal fleet • Generation recovery plan • Decommissioning/ extension of life
Grid capacity and the impact of the rate and pace of renewable rollout	• Significant growth in private embedded and rooftop generation • Grid constraints have emerged as a key constraint in certain supply areas in South Africa, but Limpopo has 3360 MW of grid available as per GCCA 2025	• Pace and extent of grid roll-out • Ability of central government to contract for required capacity • Financing options for infrastructure deployment?	• Transmission capacity • Generation connection capacity requirement
Generation potential in other regions in the country	• Prospects of gas-to-power options considered by other Provinces • IRP 2023 provides for 2.5 GW of nuclear in 2035 • Large sources of hydro in the region have been subject to delays and challenge	• Possibility of nuclear by 2035? • Possibility of regional hydro? • Possibility of gas as support for renewables?	• Nuclear assumptions • GAS IPPPP • Availability and price of energy sources

Figure 71: Key factors considered for the modelling scenarios

Projections for the country's electricity demand show an increase regardless of the economic growth scenario. Figure 72 outlines two pathways: a low economic growth scenario and a high economic growth scenario. In both cases, demand is expected to rise rapidly from the ~240 TWh as shown for 2023. The low economic growth assumption projects an annual average growth rate of 0.5%, whereas the high economic growth assumption anticipates a rate of 1.6%. With the lower growth assumption, demand for electricity is forecast to reach 421 TWh (59 GW) by 2050. The high economic growth scenario suggests an even steeper rise in demand, reaching 429 TWh (60 GW) by 2050. Both scenarios are largely attributed to the electrification of the transport industry[224,225,226].

[224] AIA analysis
[225] Merven Bruno (2023
[226] ESRG Single Node Hourly Demand Model. University of Cape Town

South Africa National Demand



Key Assumptions

Driver	Details	Low Scenario	High Scenario
GDP growth rate	Annual average growth rate	0.5%	1.6%
Base year	Due to Covid-19 and minimal load shedding effect	2017	
Primary demand projection	Projected electricity demand	421 TWh	429 TWh
Growth post-2030	Main factors driving demand	Electrified transport sector	Electrified transport sector
Peak demand by 2050	Growth from current to projected peak demand	59 GW	60 GW

Figure 72: South Africa's energy demand based on a low and high scenario

4.4.2 Scenarios

Based on these assumptions, two scenarios have been developed for Limpopo. Scenario 1 (Figure 73) outlines a pathway for the province to achieve energy security. Limpopo faces challenges in achieving energy security due to its dependence on Eskom. Eskom's implementation of manual load reduction (MLR) during peak demand periods significantly decreases available power to the province, highlighting the vulnerability of a single-source energy model.

A key strategy outlined in Scenario 1 for achieving energy security in Limpopo involves a diversified energy mix that reduces reliance on Eskom. This scenario emphasizes the development of renewable energy sources within the province, including solar, wind, hydro, and biomass power generation. This scenario acknowledges the potential contribution from various stakeholders. Utility-scale Independent Power Producer projects can contribute by supplying power directly to the grid. Commercial and industrial sectors can also play a role by generating their own renewable energy to meet their specific needs, thereby reducing their reliance on the grid. Additionally, residential solar power generation is identified as a potential contributor.

The successful implementation of this scenario hinges on three critical pillars: policy, capacity building and infrastructure development. Enabling policies are crucial to incentivize and support renewable energy investment and development in Limpopo. Building a skilled workforce is equally important, as it ensures the availability of qualified personnel to design, implement, and maintain these renewable energy projects. Finally, targeted investments in grid infrastructure are essential to effectively integrate and transmit renewable energy into the provincial power grid.

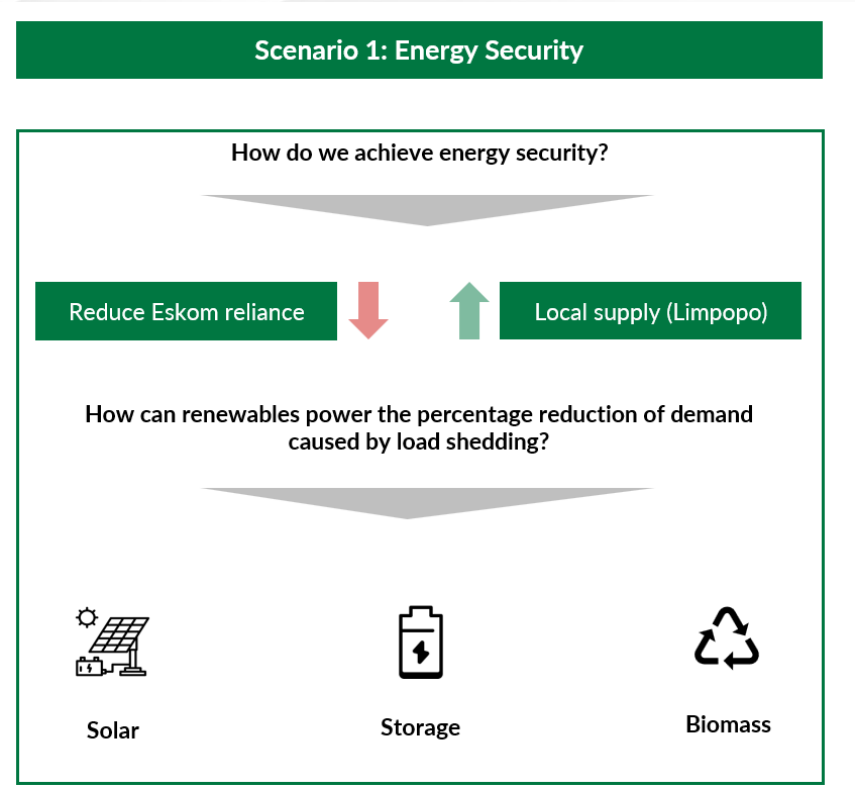


Figure 73: Scenario 1: Energy security

Scenario 2 investigates Limpopo's goal of reaching net-zero emissions by 2050 (Figure 74). To ensure a fair and inclusive transition, this scenario prioritizes quantifying Limpopo's specific share of South Africa's total CO_2 emissions from electricity generation. However, there are a few socio-economic issues that need to be considered:

- **Employment Shifts:** Traditional fossil fuel workers may face job losses, and no one-on-one replacement with new jobs in renewable sector
- **Skill Gap and Retraining:** Significant retraining and education programmes (Further Education and Training college (FET) and Technical and Vocational Education and Training (TVET) Colleges specified by Vhembe and Mopani districts)
- **Energy Affordability:** Transitioning to new energy systems may include upfront costs leading to higher energy prices in short term i.e. disproportionately affecting low-income households
- **Equitable Access to Energy:** Marginalised communities and those suffering from energy inequities must be included in transition to ensure benefits shared widely and equitably

This essentially leads to a key question; what Limpopo's grid emission factor would be should the province add 10% of renewables to its energy mix.

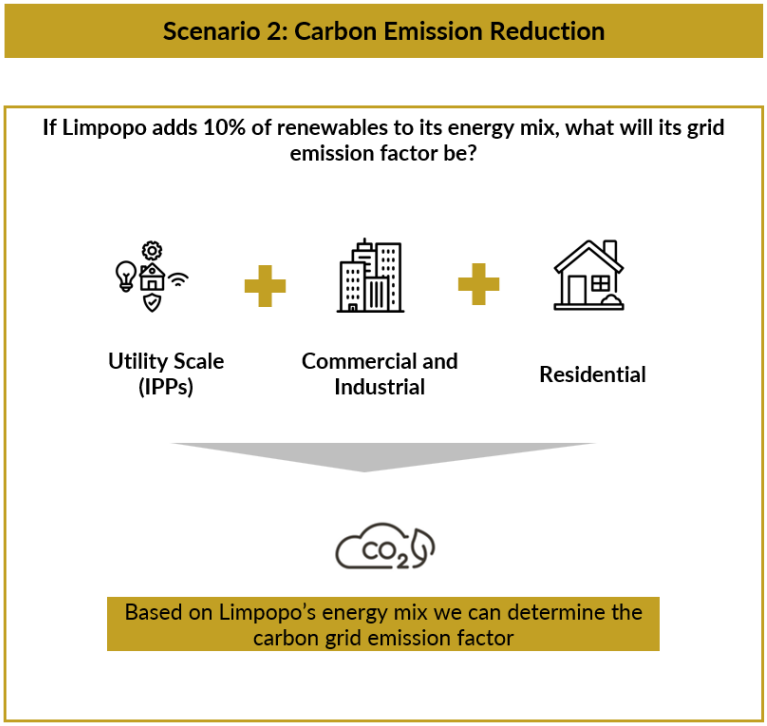


Figure 74: Scenario 2: CO2 emission reduction

5 INTERVENTION STRATEGY

5.1 Introduction

Given these multifaceted considerations, modelling renewable energy scenarios in Limpopo presents a complex interplay of factors. While electrification rates are increasing and grid capacity is available, challenges such as reliance on firewood, economic fluctuations, and limitations in government contracting capacity must be considered. The deteriorating performance of Eskom's coal fleet and the exploration of alternative energy sources like gas, nuclear, and hydro further complicate the landscape. Amidst these complexities, the potential for renewable energy integration in Limpopo is significant, warranting a detailed analysis of various scenarios.

The intervention strategy for Limpopo sought to balance electrification efforts with sustainable alternatives for traditional energy users, while aligning energy projections with realistic economic scenarios. It aimed to maximise the use of existing grid capacity for renewable integration and advocated for streamlined policies to facilitate project deployment. Recognising the uncertainties surrounding Eskom's coal fleet, the strategy prioritized a diversified approach, exploring the potential of solar, wind, and other renewable energy sources. By incorporating these foundational elements, the intervention strategy aims to create a comprehensive and adaptable framework for promoting renewable energy adoption in Limpopo.

The section presents two scenarios:

- **Scenario 1:** This scenario is unfolding in response to the ongoing challenges of an unreliable national power grid and frequent load shedding. The province is strategically shifting away from reliance on the national electricity provider, Eskom, and embracing a diversified energy approach. This includes harnessing abundant solar resources through extensive infrastructure, investing in advanced energy storage technologies, and exploring the potential of biomass energy from organic waste.

- **Scenario 2:** Scenario 2 focuses on carbon emission reduction. The province aims to incorporate renewable energy sources into its existing energy mix, comprising utility-scale power plants, commercial and industrial sectors, and residential consumption. This strategic shift towards cleaner energy sources is expected to impact Limpopo's carbon grid emission factor.

This section serves as a vital resource for policymakers, industry leaders, and stakeholders invested in the future of Limpopo's energy landscape. By providing a clear picture of the current situation and exploring potential pathways, decision-makers have information on how to navigate the energy transition for a more secure and sustainable future.

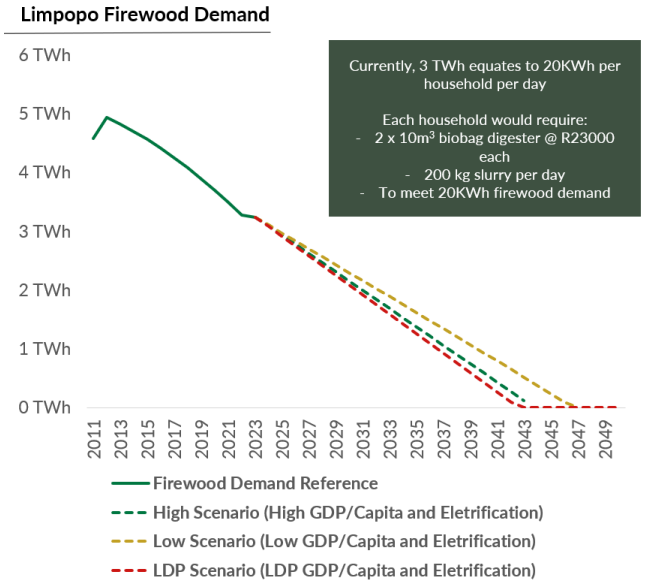
5.2 Demand

Limpopo faces a dynamic landscape when it comes to its projected electricity demand by 2050 (Figure 75). Economic expansion and population growth are expected to be the primary drivers pushing demand upwards.

Projected GDP growth, ranging from 0.5% to 2% annually, can significantly impact electricity consumption across various sectors. Based on Limpopo's Development Plan (LDP), a robust economic growth scenario (LDP scenario) with a 2% GDP growth rate, businesses and industries will require more energy to fuel their operations, leading to a substantial increase in demand. Conversely, a more sluggish economic scenario (low scenario) with a 0.5% GDP growth rate would likely result in a more moderate rise in demand. Population growth, although projected to remain relatively flat at around 10.55 million by 2050, also plays a role. This translates into a larger consumer base relying on the provincial power grid. Under the high scenario, this could

translate to a potential demand increase of 46.92 TWh by 2050. The low scenario would likely result in a lower demand increase, potentially closer to 36.97 TWh by 2050[227,228].

However, there is a potential mitigating factor, the CPI, suggesting that rising prices could dampen economic activity and consumer spending on electricity. This potential effect might lead to a downward revision of the high scenario projections. Forecasting Limpopo's long-term electricity demand presents a complex challenge. While economic growth and population expansion are anticipated to drive demand upwards, inflationary pressures might act as a countervailing force.



Key Assumptions

Driver	Details	Low Scenario	High Scenario	LDP Scenario
GDP growth rate	Annual average growth rate	0.5%	1.6%	2.0%
Primary demand projection	Projected demand of firewood	Demand goes to zero by 2047	Demand goes to zero by 2044	Demand goes to zero by 2043
GDP/Capita post 2030	Factor driving down demand	36,253	48,352	54,084
Number of households using firewood	Main factor negating demand	13,009 pre-2047	15,533 pre-2044	13,146 pre-2043

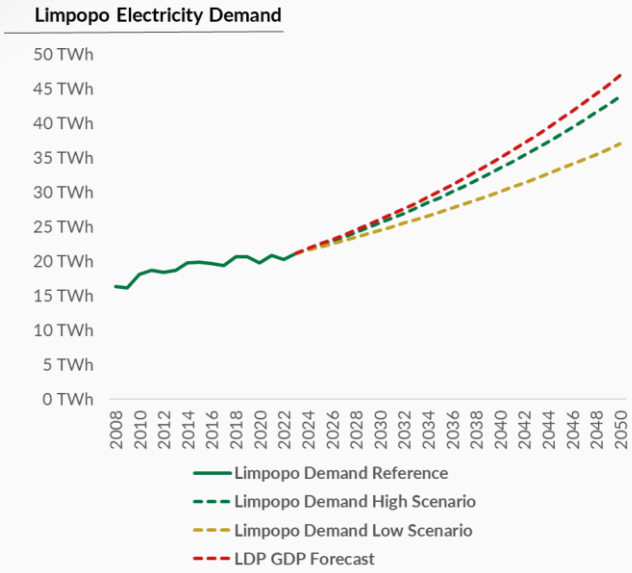
Figure 75: Limpopo firewood demand

An analysis of Limpopo's firewood demand indicates a transition towards sustainable energy practices (Figure 76). There are three future scenarios, all of which predict a significant decline in firewood use. This decline is primarily attributed to increasing electrification rates across the province. The scenarios explore the impact of varying economic growth trajectories (high vs low GDP growth). The LDP scenario assumes a higher annual average GDP growth rate (2%) and a higher GDP per capita by 2030 (R 54 084) compared to the high scenario which assumes a higher annual average GDP growth rate (1.6%) and a higher GDP per capita by 2030 (R 48 352). The low scenario assumes a lower GDP growth rate (0.5%) and a lower GDP per capita by 2030 (R 36 253)[229,230,231].

The widespread electrification is expected to eliminate firewood dependency for heating purposes. The low scenario shows demand going to zero by 2047 and the high scenario shows demand going to zero by 2044. The LDP scenario shows demand going to zero by 2043. This trend highlights the critical role that electrification plays in curbing reliance on traditional biomass fuels like firewood. Firewood collection can contribute to deforestation and environmental degradation, while its use for heating releases harmful pollutants. While increased income might lead to a shift towards cleaner, more convenient electric heating options, the primary driver for reduced firewood demand appears to be electrification efforts.

[227] AIA analysis
[228] StatsSA
[229] AIA anlysis
[230] StatsSA
[231] Masekela and Semenya (2021)

If we aim to replace the energy equivalent of 3 TWh of firewood consumption with biogas, this will translate to roughly 20 kWh of biogas per household per day. To achieve this, each household might require a setup involving two 10 m^3 biodigesters, with an estimated cost of R23 000 each, and a daily feedstock input of 200 kg of organic slurry[232]. With an estimated 276 949 households projected to rely on firewood by 2030, transitioning them all to biodigesters would require an investment of roughly over R12 billion.



Key Assumptions

Driver	Details	Low Scenario	High Scenario	LDP Scenario
GDP growth rate	Annual average growth rate	0.5%	1.6%	2.0%
Primary demand projection	Projected electricity demand 2050	36.97 TWh	43.89 TWh	46.92 TWh
GDP Limpopo post 2030	Factor driving demand	R382 Billion	R510 Billion	R570 Billion
Population 2050	Second factor driving demand	10.55 Million	10.55 Million	10.55 Million
CPI electricity 2050	Main factor negating demand	431	431	431

Figure 76: Limpopo electricity demand

Figure 77 illustrates a projected increase in electricity demand across the province. This growth is attributed to factors such as improved electricity access, expansion in the mining and agriculture sectors, and commercial and light industrial development. The figure indicates that peak demand is expected to reach 5,069 MW by 2032. Notably, Phalaborwa, Polokwane, and Lephalale are predicted to experience significant demand increases due to various factors including electrification, mining activities, and commercial development.

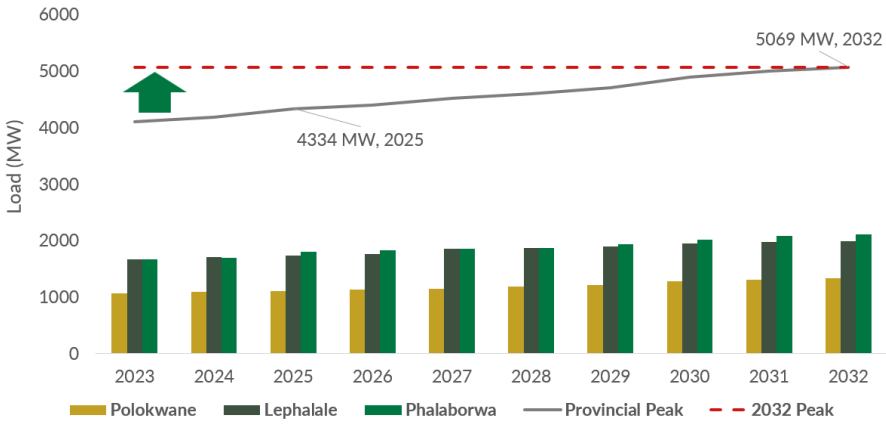
The University of Venda's involvement in the "Promoting Organic Waste-to-Energy" project, funded by GEF and administered by UNIDO, demonstrates its commitment to renewable energy research. Similarly, the University of Johannesburg's multidisciplinary research, particularly in their PhD program in Biodiversity and Conservation, suggests potential for biodigester-related studies. While specific contributions to biodigester

[232] Biogas Consulting SA

technology are not explicitly documented, these research endeavours underscore the importance of academic institutions in driving innovation in renewable energy.

This rising electricity demand necessitates continued investment in power generation capacity and grid infrastructure. Expanding access to electricity is crucial for improving living standards and economic opportunities in Limpopo. However, it's imperative to adopt a sustainable and environmentally conscious approach to meet this growing demand. Investing in renewable energy sources and energy efficiency measures can help minimise the environmental impact of increased electricity consumption.

Limpopo demand forecast, TDP (2022)



Economic sectors driving demand growth

- Phalaborwa demand growth is driven by increased electricity access, agriculture and chrome mining
- Polokwane as well sees increased electrification, agriculture and diamond and coal mining
- Lephalale has an increased load driven by commercial and light industrial growth together with increased electrification
- Overall, the TDP 2022 assume increased demand mainly driven by the mining and agriculture sectors

Figure 77: Limpopo demand forecast as per the TDP (2022)

An important point to note is that energy efficiency and demand side management will have an impact on the demand requirements for Limpopo. The National Energy Efficiency Strategy (2015) aims to curb energy consumption and intensity across various sectors in South Africa. SANEDI (The South African National Energy Development Institute) plans to implement several programs to achieve this goal. These programs target various sectors including residential, commercial, industrial and transportation (Figure 78). The success of these programs is expected to reduce energy demand. To optimize future provincial energy planning, the effectiveness of these programs in reducing demand needs careful evaluation.

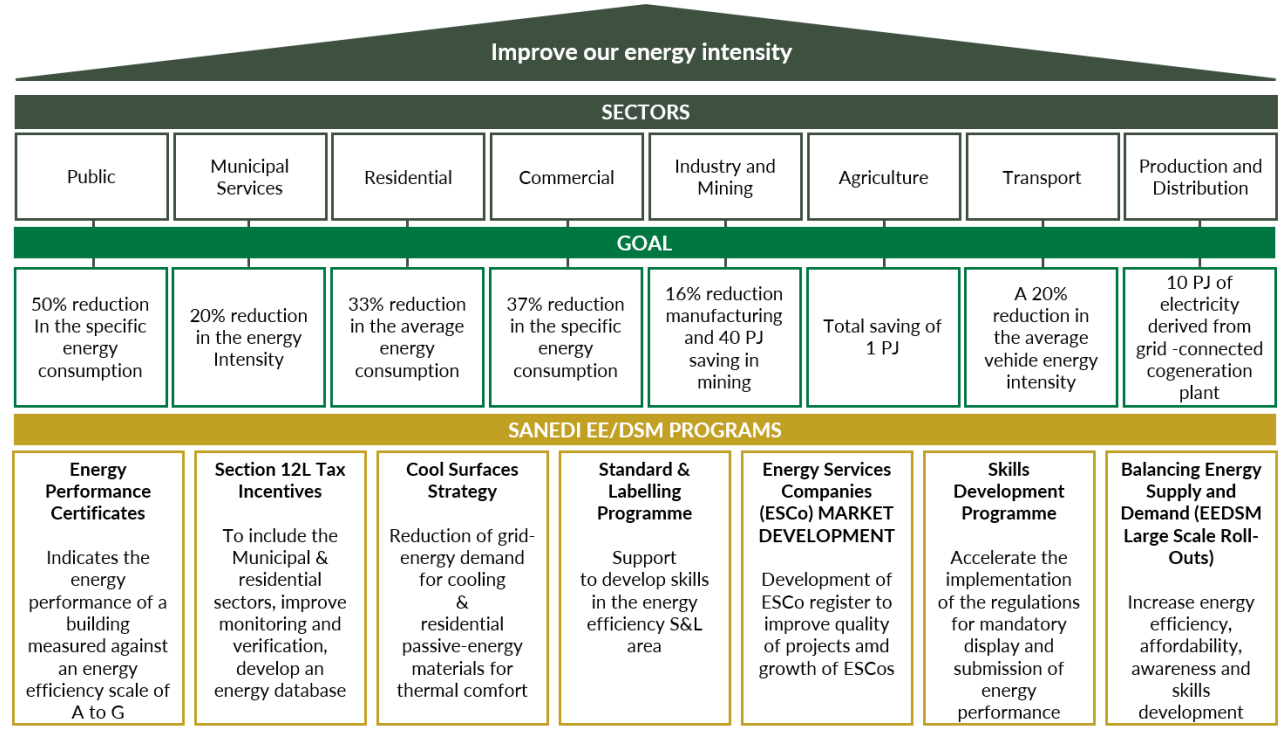


Figure 78 Energy intensity initiatives

5.3 Supply Options

To assess the potential for reducing reliance on the national grid in Limpopo, a multi-step approach was used (Figure 79). The process began by analysing the current state of South Africa's electricity sector, particularly focusing on the national electricity deficit. AIA leveraged publicly available information and existing modelling reports to forecast electricity supply and demand trends within the country up to the year 2030.

These reports included key resources such as Eskom's TDP, the GCCA (2025), the IRP (2019 and 2023) and the Medium-Term System Adequacy Outlook 2024-2028 (MTSAO) amongst others. By analysing this data, AIA could gain insights into future grid capacity limitations and potential shortfalls in generation capabilities. Based on this initial analysis, a PLEXOS energy model was developed. PLEXOS is a software program used for power system modelling and optimization. Through simulations within the PLEXOS model, the potential for an energy deficit was identified if additional generation capacity wasn't introduced in the country. The model factored in national deficit projections and assigned a proportional share of the shortfall to Limpopo, which equated to 10%. The results obtained from the model served as a critical foundation for developing strategies to reduce the provinces reliance on the national grid.

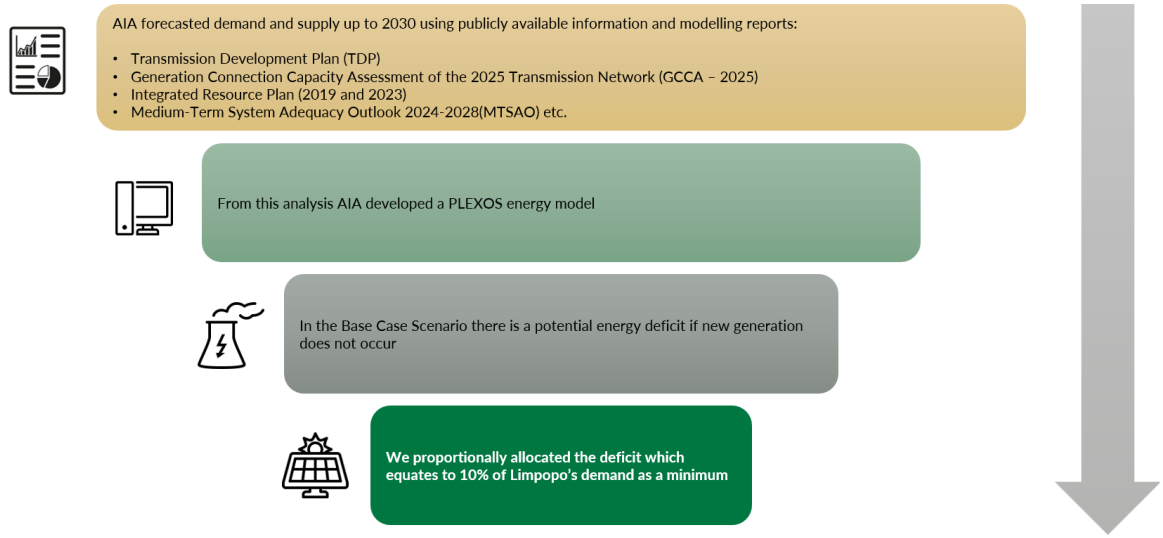


Figure 79:Methodology used to determine reduction in reliance

Limpopo faces a growing energy demand and to ensure energy security and a 10% reduction in grid reliance by 2030, a significant investment in renewable energy sources is required (Figure 80)[233].

To achieve this, the province will require 1 500 MW of renewable energy capacity by 2030, with solar power playing a key role. A solar build of 1 300 MW is targeted by 2027, with an additional 200 MW to come online by 2030. However, a crucial element for reliable renewable energy integration is dispatchable capacity, the ability to deliver power on demand. The plan proposes a large-scale Battery Energy Storage System (BESS) with a target of 7 200 MW by 2027.

While battery storage holds immense potential, achieving such a high BESS capacity within this timeframe might be challenging. To address this, it must be acknowledged that there is a need to explore alternative storage options alongside BESS. These alternatives include utilizing natural gas, pumped storage hydropower and buying power back from the national grid during peak hours through the NTCSA.

The success of renewable energy requires unlocking the full potential of solar PV installations across various sectors. Encouraging utility-scale solar farms, promoting rooftop solar adoption in the residential sector and fostering solar solutions in commercial and industrial facilities are all critical aspects.

[233] AIA analysis

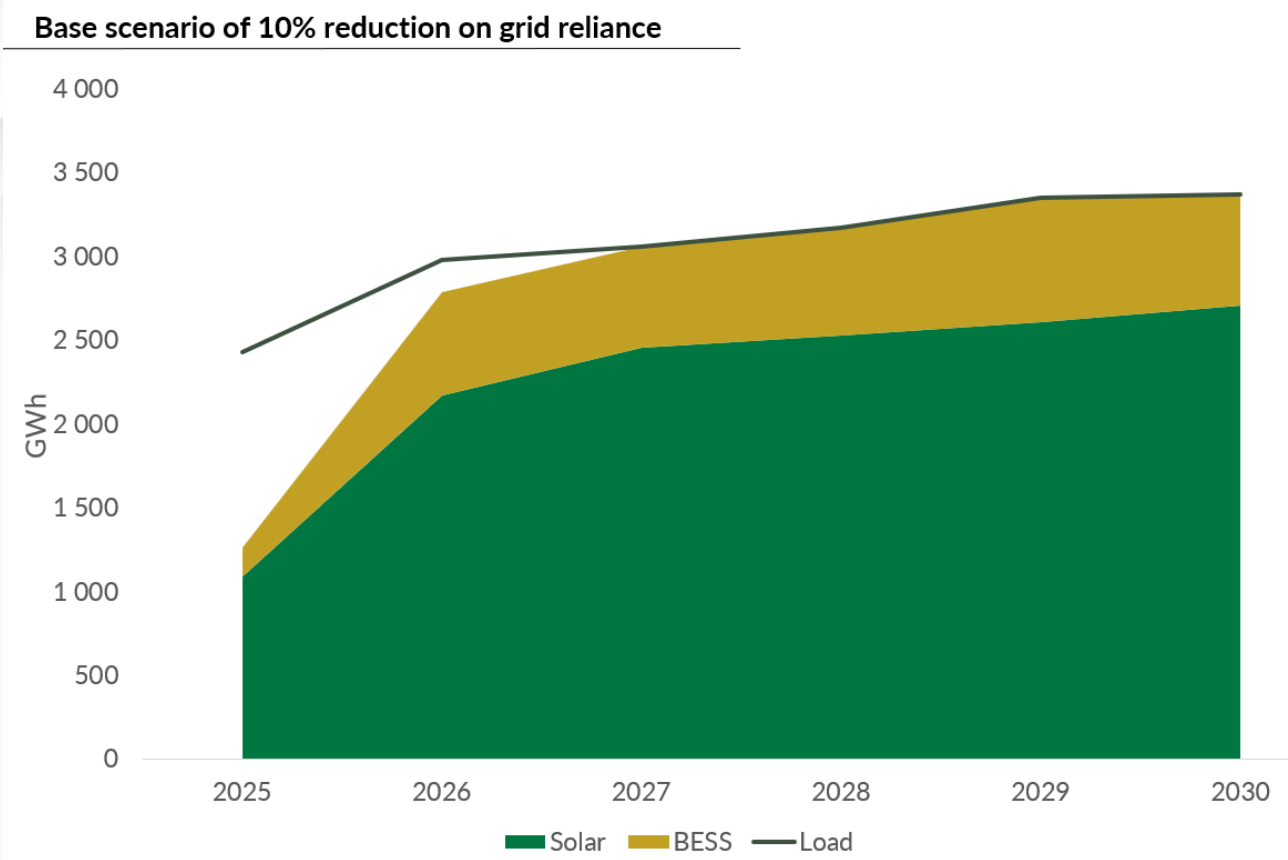


Figure 80: Base scenario of 10% reduction on grid reliance

The hourly profile in Figure 81 illustrates the interplay between solar energy availability and energy demand. Solar energy is the dominant source of power generation between 7:00 AM and 5:00 PM, which coincides with a period of lower energy demand[234]. Conversely, during the night and early morning, when solar is unavailable, energy demand is at its highest, particularly for the residential sector. BESS are crucial during these off-peak hours, as they can store excess solar energy generated during the day and discharge it to meet peak demand requirements. This integrated approach is essential for ensuring grid stability and security.

[234] AIA analysis

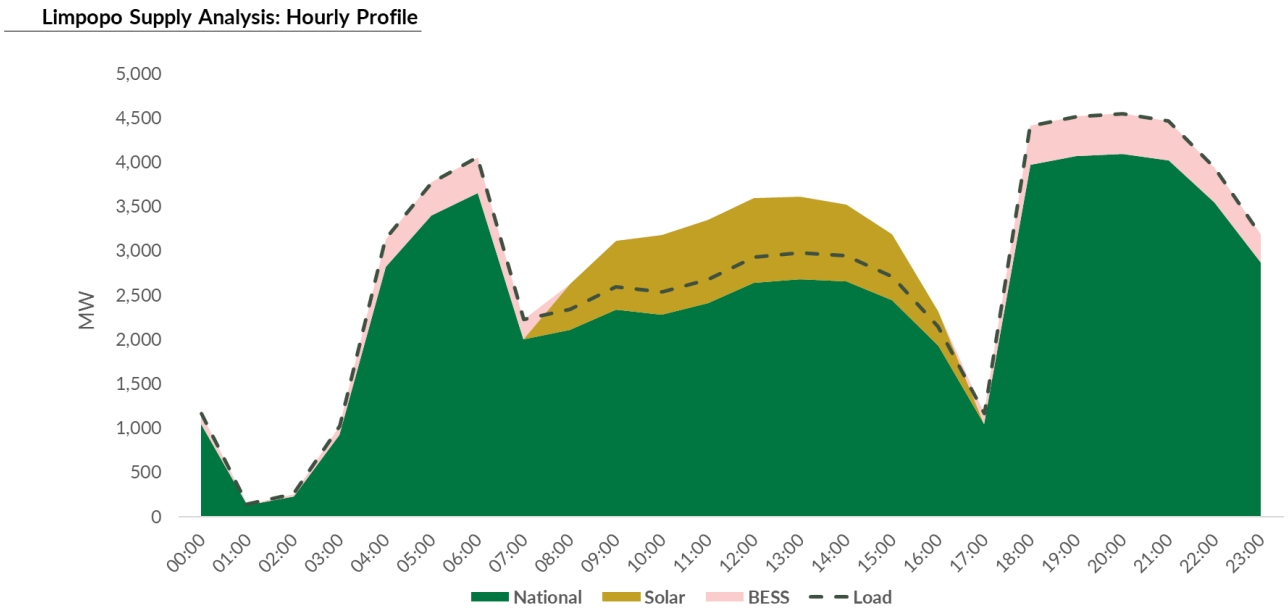


Figure 81: Hourly profile indicating when solar energy is dominant

Limpopo could achieve a much larger reduction in reliance on the national grid by 2030 by committing to a 400 MW annual rollout of solar power (Figure 82)[235]. This approach has the potential to surpass the initial target of a 10% reduction. By implementing this, the model projects an excess capacity of 900 MW, generating an additional 1 971 GWh of solar energy by 2030.

This surplus generation capacity translates to a total projected reduction in reliance on the grid by 19%. If this solar rollout is pursued, the final energy mix in 2030 is likely to include a significant contribution from solar alongside BESS with a projected total capacity of 2 674 GWh from solar and 462 GWh from BESS by 2030.

[235] AIA analysis

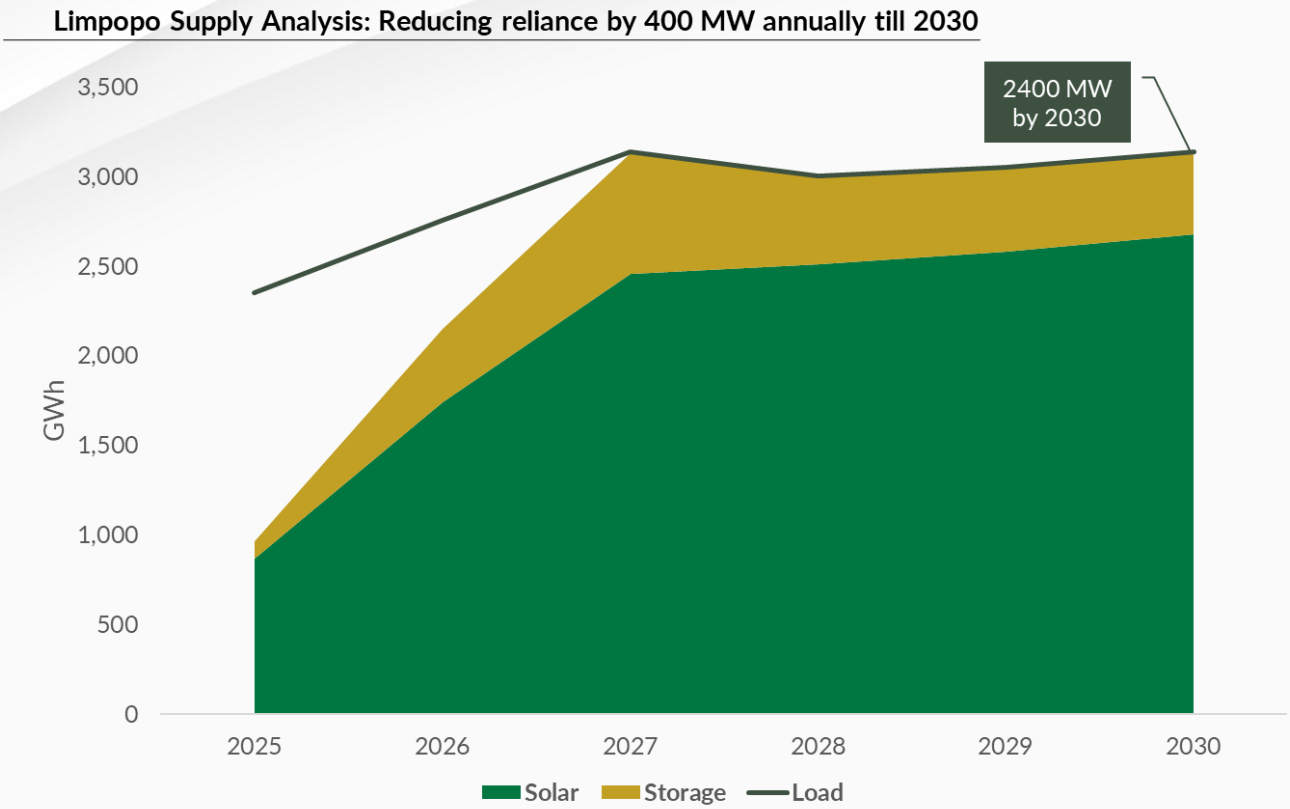


Figure 82: Solar build of 400 MW per annum

While the initial scenario proposed a substantial BESS rollout of 7 200 MW by 2027, a more measured approach may be considered. Given that the contracted capacity of between 77 MW and 103 MW from the first Battery Energy Storage bid window, a build rate of 100 MW per year from 2025 appears more achievable (Figure 83)[236,237].

This approach would result in a total BESS capacity of 600 MW by 2030. Even with this more modest BESS target, the province can achieve a significant reduction in grid reliance. Solar energy rollout is expected to play a major role in achieving this target, however, grid reliance will still be required with a projected deficit of 153 GWh by 2030. This deficit can be addressed through purchasing power from the national grid during peak demand periods.

[236] AIA analysis
[237] IPP storage

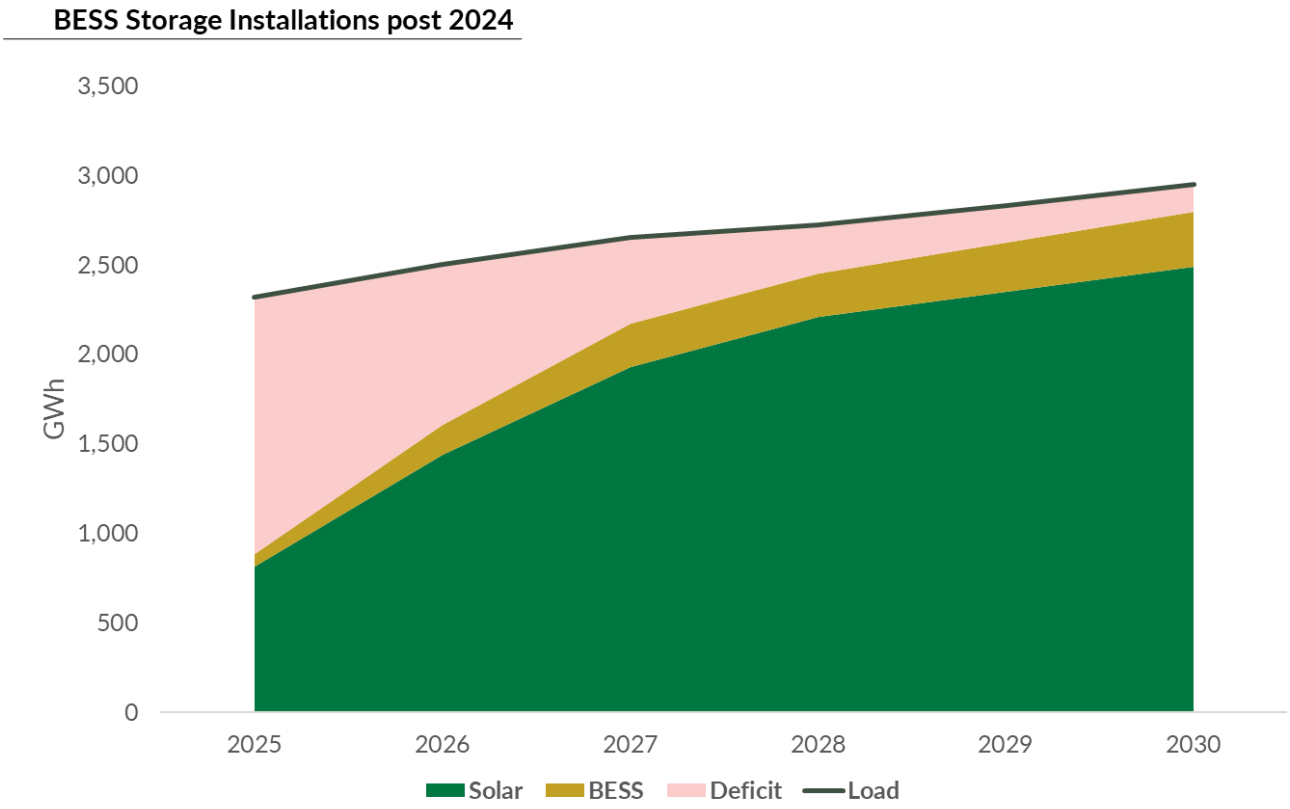


Figure 83: BESS storage builds of 100 MW per annum

Limpopo's ambitious renewable energy rollout strategy, aiming for a 10% or even a 19% reduced reliance on the grid by 2030, is expected to deliver significant environmental benefits alongside energy security.

A key factor influencing the impact on CO_2 emissions will be the performance of the existing coal fleet. A low performing coal fleet, requiring supplemental gas backup of 5 GW (with an EAF 51%), will lead to a lower grid emission factor compared to a high performing fleet that can operate without additional gas (with an EAF of 65%) (Figure 84)[238].

With these scenarios, by 2030, Limpopo's grid emission factor would be 0.495 tCO_2/MWh and 0.603 tCO_2/MWh for low and high performing coal fleets, respectively, under the 10% grid reliance reduction scenario.

However, if Limpopo achieves the more ambitious target of a 19% reduction by 2030, the grid emission factors could decrease to 0.105 tCO_2/MWh and 0.127 tCO_2/MWh for low and high performing coal fleets, respectively. This highlights the critical role that both renewable energy deployment and coal fleet optimization play in decarbonizing Limpopo's grid.

[238] AIA analysis

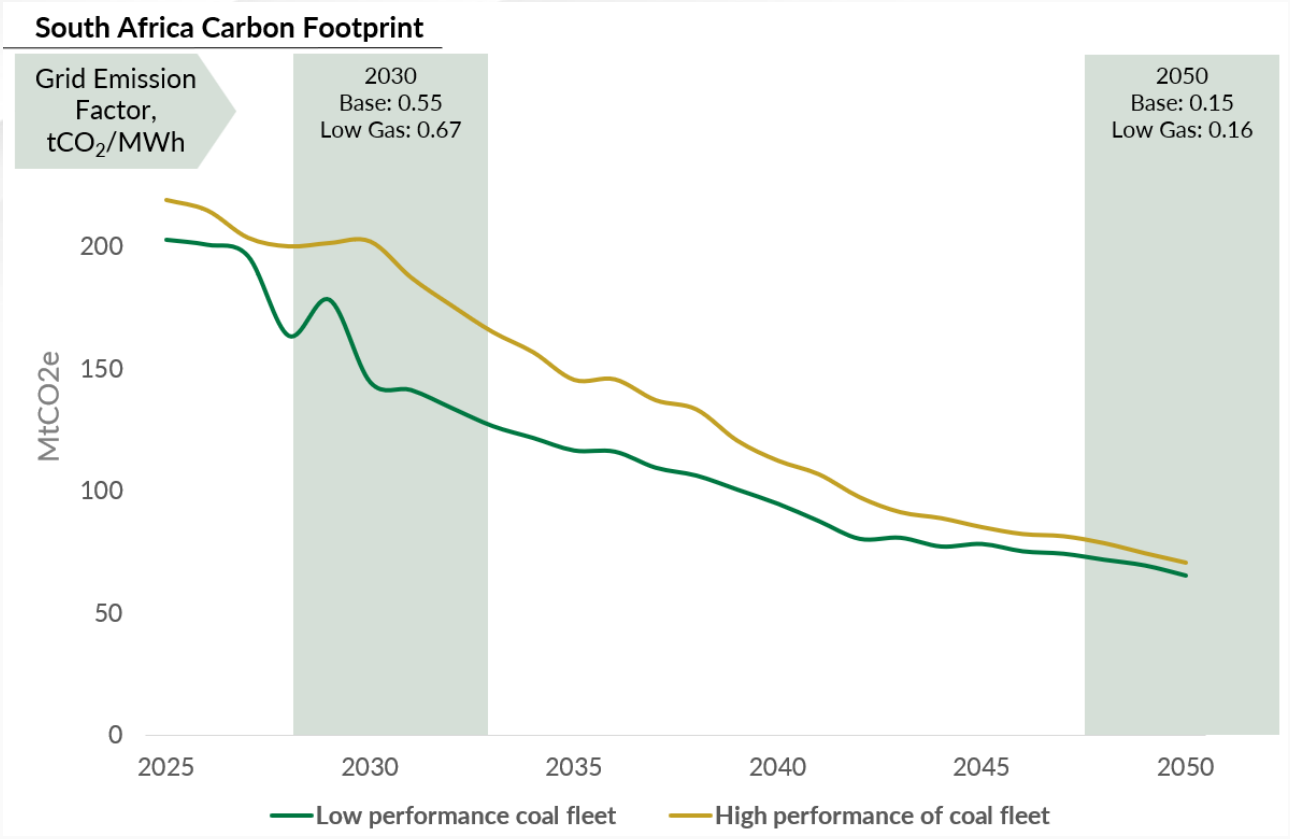


Figure 84: Grid emission factors

Solar PV has been identified as a cost-competitive and attractive renewable energy option for Limpopo. However, the economic feasibility varies depending on the scale of the project as indicated in Figure 85. Utility-scale solar emerges as the most cost-effective solution, with capital expenditure estimates ranging from approximately ~$700/kW to ~$1 400/kW. In contrast, utility scale PV with storage ranges between ~$1 075/kW to ~$1 600/kW. The price range for community, commercial and industrial (C&I) solar PV is slightly higher, ranging from ~$1 200/kW to ~$2 850/kW with residential solar installations having the highest costs ranging between ~$2 230/kW and ~$4 150/kW[239].

This substantial price disparity highlights the critical role of policy instruments in promoting widespread solar PV adoption across all sectors. Strategic policy interventions are necessary to incentivize and support the rollout of residential, commercial, and industrial solar installations alongside utility-scale projects. While the upfront cost of solar PV may be higher than traditional energy sources, it's crucial to consider the long-term economic benefits.

Solar offers significant cost savings over the project lifespan, coupled with environmental advantages through reduced greenhouse gas emissions. Therefore, despite the variations in cost per kilowatt depending on scale, solar PV remains a relatively affordable and increasingly attractive option compared to traditional energy sources.

[239] Lazard Levelized Cost Of Energy Analysis (2023)

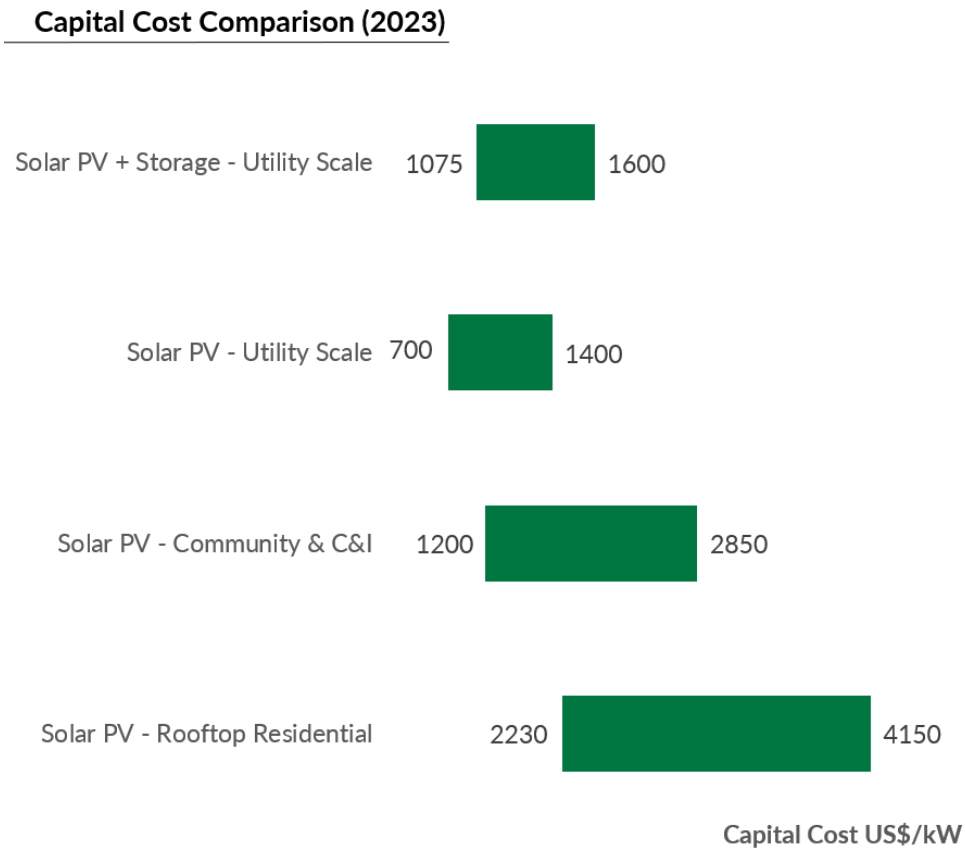


Figure 85: Capital cost comparison at various scales

According to a forecast of 4-hour BESS costs, a significant decrease is anticipated between now and 2050. Figure 86 depicts three trajectories advanced, moderate, and conservative, all indicating a downward trend in costs for commercial scale BESS. Under the advanced scenario, the cost per kilowatt-hour per year is projected to decrease from around $1 693 in 2024 to roughly $802 by 2050. The conservative scenario expects a decrease from $2 543 to $1 921 between now and 2050. These reductions suggest that BESS technology will become increasingly cost-competitive within the energy sector over the coming decades[240].

[240] The National Renewable Energy Laboratory (2024)

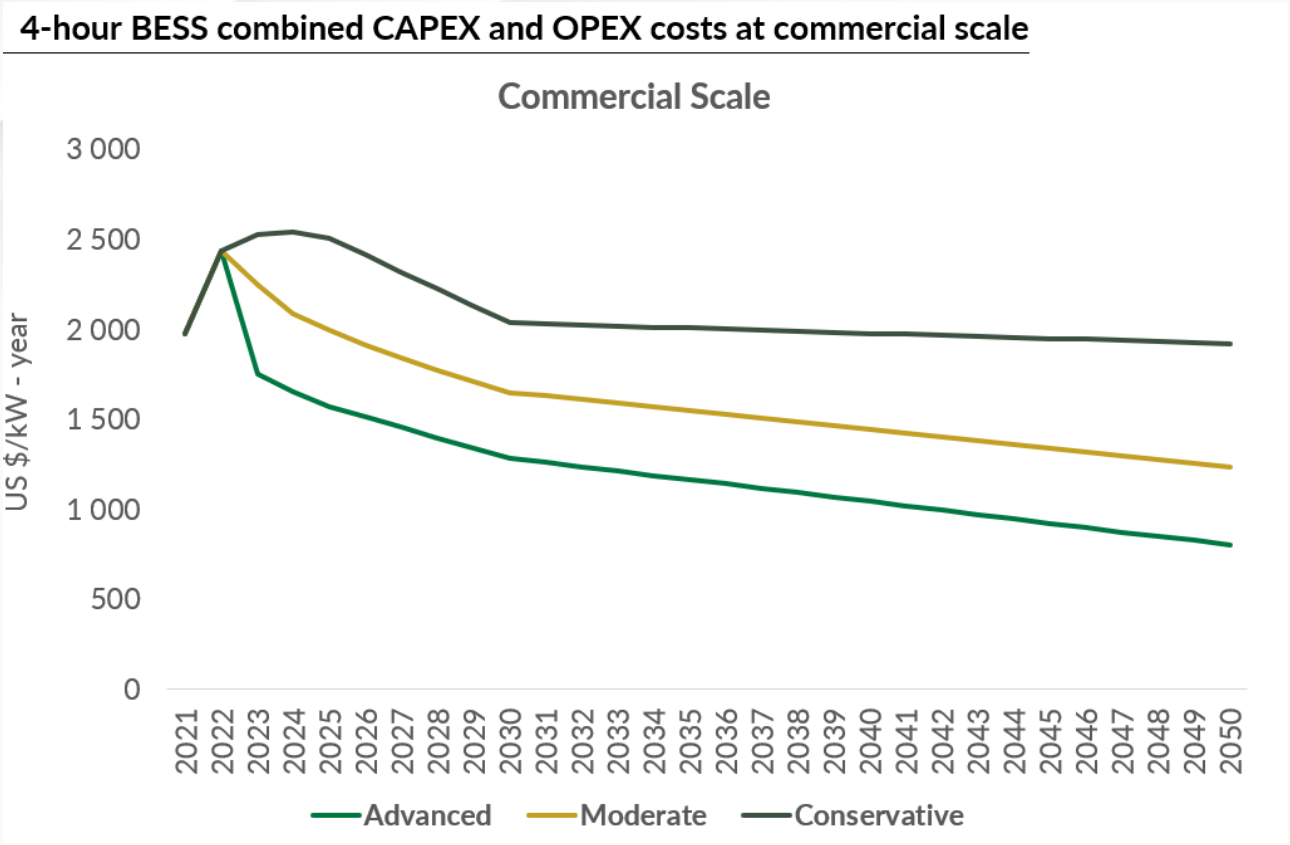


Figure 86: Combined CAPEX and OPEX cost at commercial scale for 4-hour BESS

Figure 87 presents a forecast of combined capital expenditure (CAPEX) and operational expenditure (OPEX) for residential 4-hour BESS up to 2050. Like commercial scale BESS, all three trajectories exhibit a downward trend, signifying anticipated cost reductions over the projected period. Notably, under the advanced scenario, the cost per kilowatt-year is expected to decline significantly, from around $3 204 in 2024 to roughly $1 555 by 2050. The conservative scenario forecast a decrease from $2 543 to $1 921 between the same period. This suggests a potential for increased cost-competitiveness of residential 4-hour BESS in the coming decades, however, residential scale 4-hour BESS remains the highest compared to commercial and utility scale.

4-hour BESS combined CAPEX and OPEX costs at residential scale

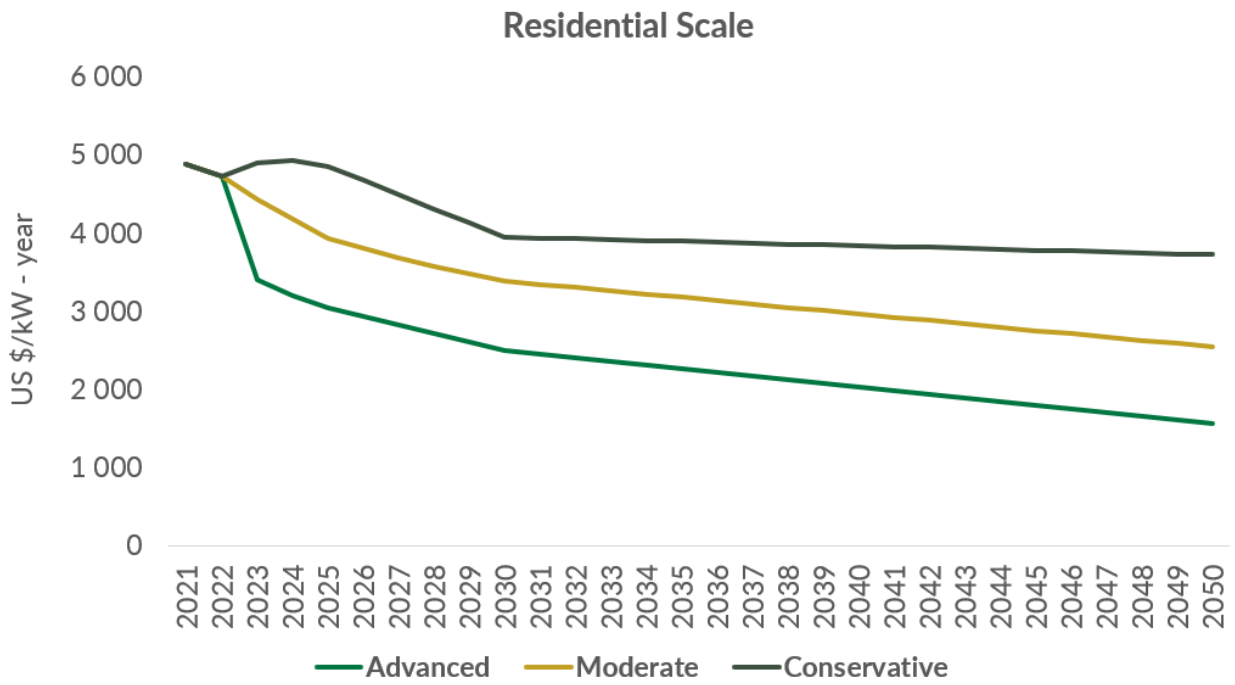


Figure 87: Combined CAPEX and OPEX cost at residential scale for 4-hour BESS

As with the case with commercial and residential scale 4-hour BESS, the combined CAPEX and OPEX cost for utility scale indicate a downward trend, suggesting a decrease in costs over time (Figure 88). Under the advanced scenario, the average cost is projected to decrease from around $1 242 per kilowatt-year in 2024 to around $603 by 2050. Under the conservative scenario, the cost is expected to decrease from $1 910 to $1 321 between 2024 and 2050[241]. This suggests that 4-hour BESS systems at utility scale is the cheapest when compared to commercial and residential scale.

In terms of total installation cost of BESS at utility scale using The National Renewable Energy Laboratory scenarios, it is estimated to between R8.9 billion to R13.75 billion assuming an exchange rate of $1 = R18. This is in line with Bid Window 1 of IPP storage which indicated an evaluation price of approximately R9 billion for 100 MW capacity[242].

[241] The National Renewable Energy Laboratory (2024)
[242] IPP Storage

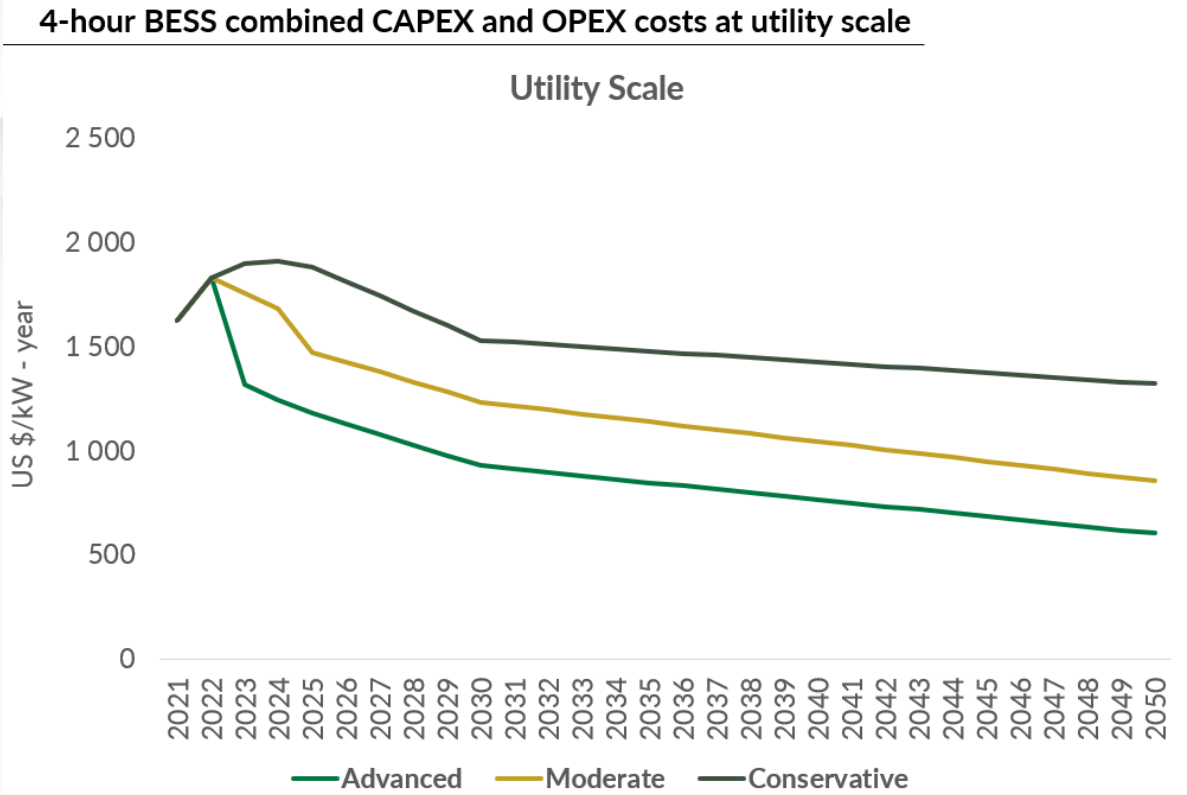


Figure 88: Combined CAPEX and OPEX cost at utility scale for 4-hour BESS

6 PROVINCIAL NORMS AND STANDARDS

6.1 Introduction

The Electricity Regulation Act (4 of 2006): Electricity Regulations for Compulsory Norms and Standards for Reticulation Services outlines regulations that aim to ensure the stability, efficiency, and security of the country's electricity supply.

The regulations establish compulsory norms and standards for the installation, operation and maintenance of electricity reticulation services. Reticulation services encompass the network of electrical lines and related equipment that deliver electricity from distribution transformers to end users. These standards, aim to promote a stable and efficient electricity grid while supporting the country's transition to more energy-efficient technologies and practices. Details on the standards can be found in the annexure.

At the foundation of this strategy are key pieces of legislation and plans such as the National Energy Efficiency Strategy, the Electricity Regulation Act, and Municipal Structures Act, which are crucial for setting the standards and norms for energy efficiency and governance. These legislative frameworks are supported by strategic support plans like the National Development Plan and the Limpopo Development Plan, which provide a roadmap for district-level development and the integration of renewable energy projects.

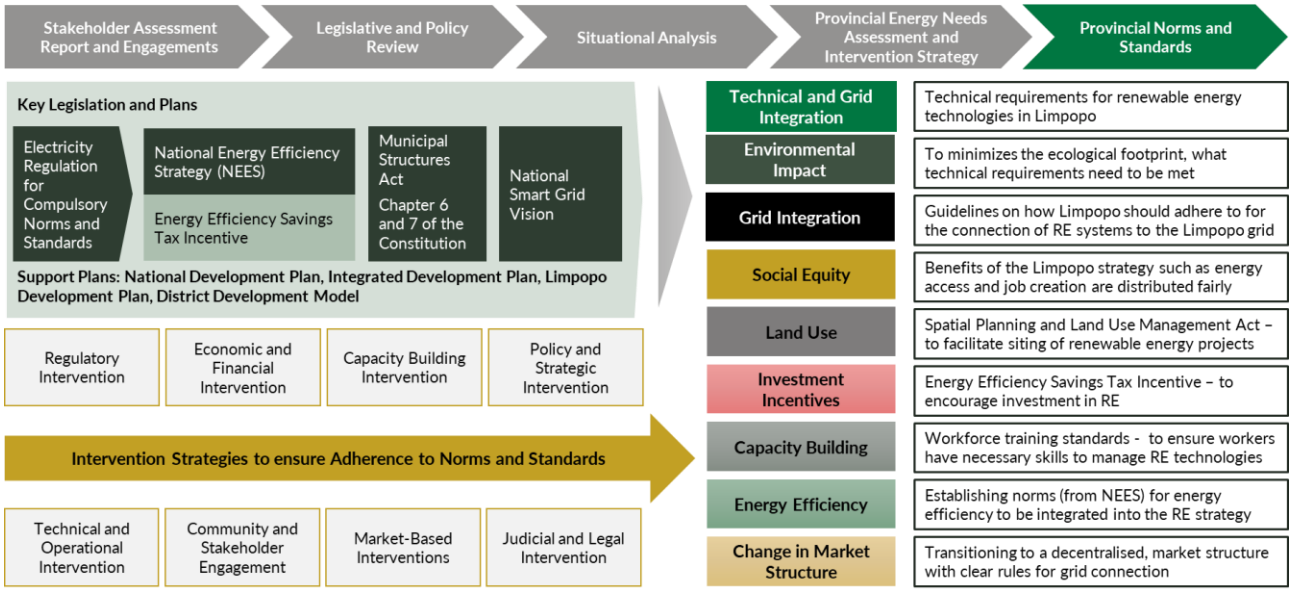


Figure 89: Provincial Norms and Standards

The strategy is implemented through a series of interventions that ensure adherence to these norms and standards. These interventions are categorised into regulatory, economic, and financial, capacity building, and policy and strategic interventions. Each category plays a crucial role in shaping the landscape of renewable energy in Limpopo (Figure 90). For example, regulatory interventions ensure compliance with energy policies, while economic and financial interventions address the affordability and investment climate necessary for renewable energy projects.

Further detailing the approach, the strategy incorporates various types of operational interventions, including technical and operational, community and stakeholder engagement, market-based, and judicial and legal interventions. Technical interventions focus on the specific requirements for renewable energy technologies and their integration into the grid, ensuring minimal environmental impact and efficient energy distribution.

Community and stakeholder engagement is pivotal for fostering broad-based support and ensuring that the benefits of energy developments are shared equitably among all stakeholders.

Moreover, the strategy highlights specific areas such as grid integration, social equity, land use, investment incentives, capacity building, energy efficiency, and changes in market structure. Each area is targeted with specific goals, such as promoting fair access to energy and job creation through social equity initiatives, facilitating the siting of renewable energy projects through land use planning and transitioning to a decentralized market structure for energy that allows for more dynamic grid connections.

6.2 Technical and Grid Integration Norms and Standards

Technical specifications and grid integration are clearly segmented into standards detailing the South African Grid Code which applies across generation, transmission, distribution, and consumer interaction phases[243] (Figure 91). Each category has its own code to ensure that the integration of renewable energy is compatible with existing grid operations, as reflected in this figure. Norms highlight the oversight and regulatory roles played by entities like the NERSA and Eskom. NERSA ensures adherence to grid codes and issues licenses to producers and utilities, whereas Eskom handles the generation, purchasing, and distribution of electricity, inclusive of renewable sources.

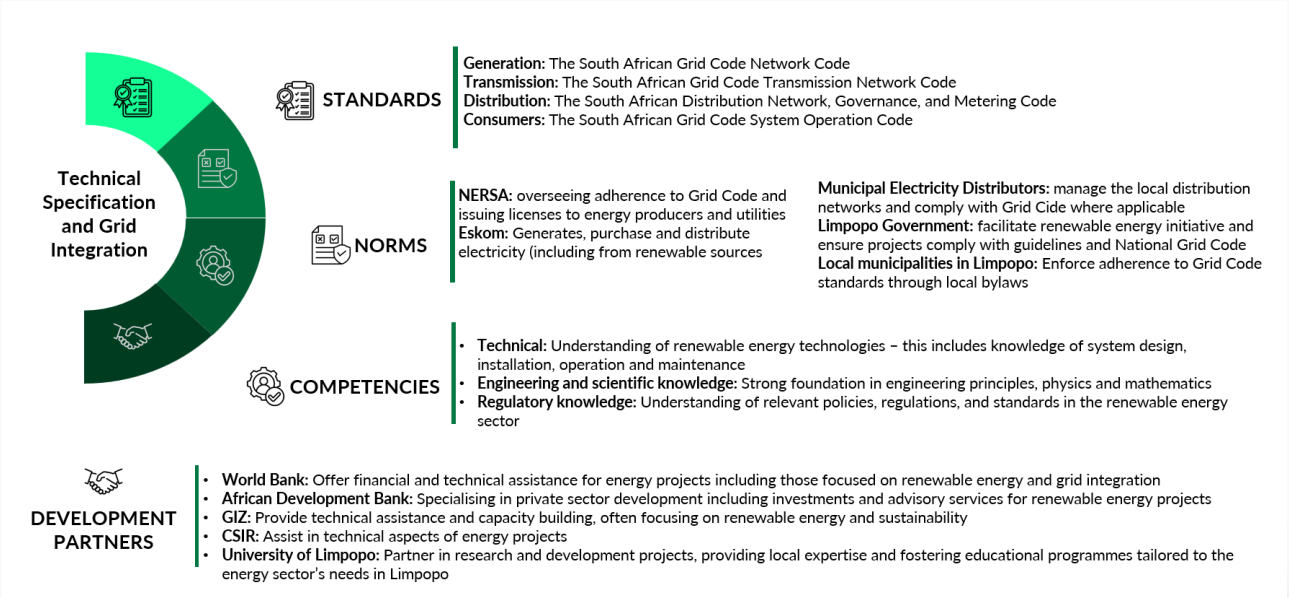


Figure 91: Technical Specification and Grid Integration Norms and Standards

The competencies outlined emphasise the necessity for a comprehensive understanding of renewable energy technologies, including knowledge of system design, installation, operation, and maintenance. Additionally, a strong foundation in engineering principles, physics, and mathematics, alongside an in-depth understanding of relevant policies and regulations in the renewable energy sector, is crucial.

Local entities such as Municipal Electricity Distributors are tasked with managing local distribution networks and ensuring compliance with the Grid Code. The Limpopo Government facilitates renewable energy initiatives, ensuring that projects comply with national and local guidelines and standards. Local municipalities are responsible for enforcing grid code standards through local bylaws.

[243] South African Grid Code (Network, Transmission Network, System Operation Code)

Development partners play a pivotal role, with organisations like the World Bank providing financial and technical assistance focused on renewable energy and grid integration. The African Development Bank specialises in private sector development, offering investments and advisory services for renewable energy projects. GIZ offers technical assistance and capacity building with a focus on renewable energy and sustainability. The Council for Scientific and Industrial Research (CSIR) assists in the technical aspects of energy projects, and the University of Limpopo partners in research and development, providing local expertise and tailored educational programmes for the energy sector's needs in Limpopo.

Evidently, it is important to align renewable energy integration in Limpopo with established technical specifications, regulatory frameworks, and competency requirements. To ensure that renewable energy sources are efficiently and effectively incorporated into the existing grid infrastructure, it is vital to highlight the collaborative efforts required between various governmental bodies, educational institutions, and international development agencies to facilitate this integration. This collaboration aims to promote sustainable energy development while adhering to the strict regulatory and operational standards necessary for the stability and growth of the grid infrastructure.

6.3 Environmental Impact Norms and Standards

Regarding the environmental impact, the Standards segment enumerates critical legislations that are foundational to environmental management and spatial planning pertinent to renewable energy projects (Figure 92). These include comprehensive acts such as the National Environmental Management Act and the Spatial Planning and Land Use Management Bill. These legislations provide a robust legal framework that ensures all renewable energy projects not only adhere to high environmental protection standards but also align with strategic spatial planning requirements essential for sustainable development[244].

Figure 92: Environmental Impact Norms and Standards

The Norms section elaborates on the roles and responsibilities of key regulatory bodies that play a crucial role in the oversight of these projects. NERSA, for instance, is tasked with ensuring that all energy projects meet stringent environmental standards before they are licensed. Similarly, Eskom, the national power provider, is

[244] Development Facilitation Act (67 of 1995)

responsible for ensuring that all projects comply with environmental laws right from the planning stage through to the implementation phase, ensuring that these initiatives do not detrimentally impact the environment.

In the Local Governance section, the responsibilities of local governmental bodies such as Cooperative Governance & Traditional Affairs (CoGTA), which oversees the implementation of spatial and land use management policies and Limpopo Economic Development, Environment and Tourism (LEDET), which assesses and monitors the environmental impacts of renewable energy projects, are detailed. These entities ensure that projects not only comply with national regulations but also contribute positively to local development, ensuring that land use is appropriately managed and that environmental impacts are minimized.

The Competencies section underscores the critical skills and knowledge areas necessary for the successful implementation of renewable energy systems. This includes a deep understanding of renewable technologies and how they can be integrated into urban planning, expertise in planning and designing areas that can accommodate such infrastructure, and proficiency in conducting Environmental Impact Assessments (EIAs). It also highlights the importance of engaging stakeholders effectively to ensure there is community support and compliance with broader environmental and regulatory objectives.

Lastly, the Development Partners section identifies key international and local organizations that provide essential financial, technical, and scientific support to these projects. This includes global institutions like the World Bank and GIZ, which offer not just funding but also technical guidance to ensure projects are sustainable and environmentally friendly, and the University of Limpopo, which contributes by conducting relevant research and offering training in environmental management and sustainability.

6.4 Change in Market Structure Norms and Standards

Figure 93 provides a comprehensive analysis of the changes in market structure necessary for integrating renewable energy systems within Limpopo, focusing on establishing standards, norms, and competencies, alongside identifying key development partners. The framework highlights specific South African Grid Codes that govern various aspects of energy generation, distribution, and transmission, which are critical for the effective wheeling, storage, and tariff setting of renewable energy[245]. Regulatory bodies like NERSA are instrumental in facilitating market entry for new participants by ensuring compliance with grid codes, while the Department of Mineral Resources and Energy aligns market structures with national energy goals to promote renewable integration. Eskom's role in adapting to market changes, potentially through unbundling or restructuring, is crucial to accommodate a more competitive renewable energy market.

[245] Guide for municipalities on how to establish and run the third-party wheeling process

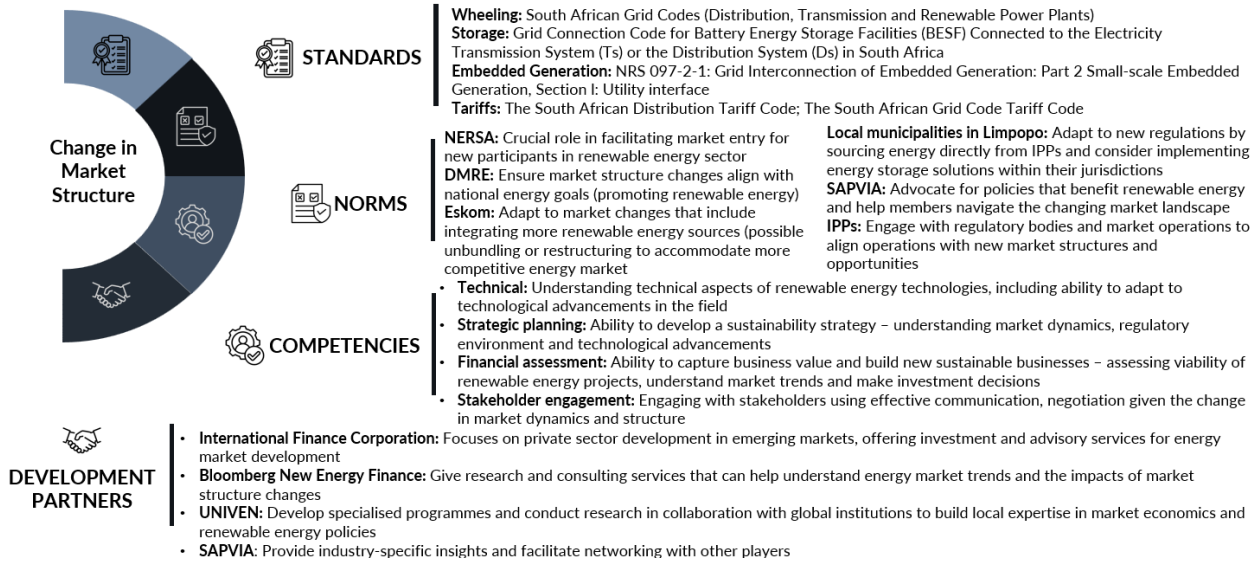


Figure 93: Change in Market Structure Norms and Standards

Furthermore, there is an emphasis on essential competencies needed for navigating the changing energy landscape, including technical expertise in renewable technologies, strategic planning to anticipate market and regulatory changes, financial assessment skills to evaluate project viability, and stakeholder engagement strategies necessary for effective communication and negotiation in evolving markets. Specific roles of local entities such as municipalities in Limpopo and industry associations like the South African Photovoltaic Industry Association are discussed, highlighting their efforts to adapt to new regulations, source energy from IPPs, and implement innovative energy storage solutions within their jurisdictions.

Development partners such as the International Finance Corporation, Bloomberg New Energy Finance, and the University of Venda (UNIVEN) are noted for their support in providing financial resources, market intelligence, and capacity-building initiatives. These collaborations are essential for understanding and adapting to market trends and the complexities of renewable energy policies, ultimately aiming to enhance the renewable energy market's structure in Limpopo to meet future energy demands and sustainability goals effectively.

6.5 Land Use Norms and Standards

In the realm of Limpopo, a meticulously structured framework governs the integration of renewable energy projects within the environmental and land use regulations. This framework is essential to ensure that all aspects of land and environmental impact are carefully managed, protecting natural resources and cultural heritage while fostering sustainable energy development.

Central to the land use framework are the Standards which incorporate several significant legislative acts such as the National Water Act, the National Environmental Management: Biodiversity Act, the Conservation and Agricultural Resources Act, the National Heritage Resources Act, and the Spatial Planning and Land Use Management Bill (Figure 94). These pieces of legislation provide a robust structure to ensure that renewable energy projects do not compromise the region's water resources, biodiversity, and heritage sites, thereby facilitating energy integration that is in harmony with environmental conservation efforts[246].

[246] National Environmental Management Act (Act 10 of 2004)

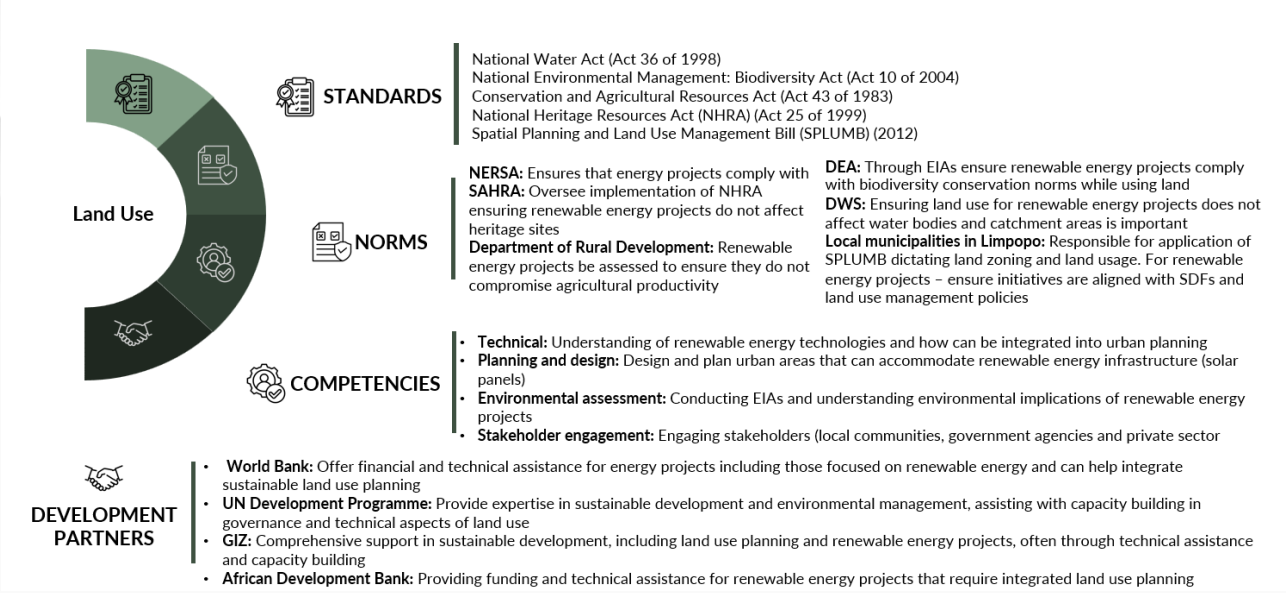


Figure 94: Land Use Norms and Standards

The Norms section delineates the responsibilities of various regulatory authorities:

- **NERSA**: tasked with ensuring that energy projects meet environmental standards.
- **South African Heritage Resources Agency (SAHRA)**: manages the protection of heritage sites, making sure that renewable energy initiatives respect historical sites.
- **The Department of Rural Development**: ensures that these projects do not hinder agricultural productivity, maintaining a balance between energy development and food security.

Local governance also plays a crucial role:

- **Department of Environmental Affairs (DEA):** oversees projects to ensure compliance with biodiversity conservation norms during land use.
- **Department of Water and Sanitation (DWS):** monitors the impact of renewable energy projects on water bodies and catchment areas.
- **Local municipalities in Limpopo:** implement the Spatial Planning and Land Use Management Bill, coordinating land zoning and usage to align with sustainable development frameworks and policies.

The Competencies essential for managing these projects include:

- Technical expertise in renewable energy technologies and their integration into urban planning.
- Planning and design capabilities to create urban areas capable of accommodating renewable energy infrastructure such as solar panels.
- Skills in environmental assessment, particularly in conducting EIAs, to understand and mitigate environmental implications.
- Stakeholder engagement abilities to effectively include community members, government entities, and the private sector in discussions and decisions related to renewable energy projects.

To support these extensive efforts, Development Partners such as the World Bank, United Nations Development Programme, GIZ, and the African Development Bank contribute significantly. They provide not just financial support but also technical assistance and capacity building, crucial for realizing the sustainable integration of renewable energy in Limpopo. Together, these elements and partnerships form a cohesive

narrative of progress, balancing ecological stewardship with the advancement of renewable energy infrastructure, paving the way for a sustainable and prosperous future for Limpopo.

6.6 Investment Incentives Norms and Standards

In the intricate landscape of Limpopo, a strategic framework unfolds, aimed at bolstering renewable energy investments through a meticulous alignment of investment incentives, standards, norms, and competencies (Figure 95). This system is crafted to not only foster clean production but also to ensure the sustainable development of the region's energy infrastructure.

Figure 95: Investment Incentives Norms and Standards

At the core of this framework are robust Investment Incentives, which include various programs designed to encourage both feasibility studies and the deployment of innovative technologies. Notable among these are the Support Programme for Industrial Innovation and the Section 11D Research and Development Tax Deduction, which aim to reduce the financial burdens on companies venturing into renewable energy technologies. Additionally, infrastructure development is supported through initiatives like the Critical Infrastructure Programme and designation of Special Economic Zones, which are tailored to enhance the region's appeal as a prime location for energy projects[247].

The Standards set forth are rigorous and ensure that all initiatives comply with essential regulations. The National Treasury plays a pivotal role here, designing tax incentives such as accelerated depreciation for renewable energy assets to ease the tax load on businesses investing in renewable energy. The Department of Trade and Industry (the DTIC) ensures that these programs align with national policies and bolster investments in renewable energy.

Under Norms, various governmental bodies like local municipalities in Limpopo work in tandem with provincial governments to ensure that local infrastructure development harmonizes with these incentives. The Development Bank of Southern Africa (DBSA) is instrumental in managing the Green Fund and financing

[247] South Africa Business Incentives Guide

projects that underpin clean energy initiatives, supporting the overarching goals of energy sustainability and environmental stewardship.

The framework also emphasizes essential Competencies required to navigate and implement these policies effectively. Technical understanding of energy systems, robust energy planning and modelling, and insights into policy design and implementation are crucial. There's a significant focus on education and training to build a knowledgeable workforce adept in renewable energy technologies and sustainable practices.

Supporting this grand vision are key Development Partners such as the United Nations Industrial Development Organization (UNIDO), United States Agency for International Development (USAID) and renowned consultancies like PwC, Deloitte, and KPMG. These partners provide not just financial and advisory support but also help in shaping policies that govern energy efficiency and sustainable development.

6.7 Capacity Building Norms and Standards

A concerted effort is underway to build a sustainable and proficient renewable energy sector. This initiative is rooted in a strategic framework designed to enhance local capacities, ensuring that the workforce and institutions are well-equipped to meet the growing demands and opportunities in the renewable energy landscape.

Central to this strategy are the Standards set forth by various authoritative bodies, including the Manufacturing Engineering and Related Services Sector Education and Training Authority (merSETA), the South African Bureau of Standards (SABS), and the Engineering Council of South Africa (ECSA) (Figure 96). These organizations ensure that the professionals involved in renewable energy projects uphold the highest quality of engineering practices and adhere to stringent standards, which are pivotal for the successful implementation of these projects[248].

Figure 96: Capacity Building Norms and Standards

Supporting these standards, the Norms focus on developmental policies crafted by entities such as the Department of Public Service and Administration. These policies are directed towards developing frameworks that emphasize staff development and efficient service delivery, tailored specifically to bolster the renewable

[248] Sector Education and Training Authority

energy sector. The local municipalities in Limpopo are particularly proactive, facilitating vocational training programmes that are custom designed to prepare the local workforce for the burgeoning opportunities within this sector.

Underpinning these efforts are the critical Competencies that individuals and teams must master to drive the renewable energy agenda forward. These include a deep technical understanding of energy consumption, transmission, and the overall workings of energy systems. Moreover, robust energy planning and modelling are emphasised to ensure security of supply, affordability, and accessibility. Additionally, there's a strong focus on policy design and implementation, where government professionals are trained to craft and enforce effective policies. Education and training are also given paramount importance, with an aim to cultivate a pool of trained professionals who can navigate the complexities of renewable energy systems.

To bolster these initiatives, Limpopo has partnered with several Development Partners such as the World Bank, which provides financial and technical assistance for sustainable development projects. Organisations like SAMechE and international bodies like Greenpeace and the World Wildlife Fund are involved in workshops and community training programmes, sharing their expertise in sustainable practices. The African Development Bank and the Department for International Development from the UK also contribute significantly, offering both funding and technical guidance.

6.8 Social Equity Norms and Standards

Central to the social equity are the robust Standards set forth by the Constitution of South Africa and the Broad-Based Black Economic Empowerment Act[249, 250](Figure 97). These foundational texts enshrine the right to equality and mandate the state to implement measures that address social and economic disparities. Specifically, they ensure that renewable energy projects not only generate power but also foster economic empowerment of black South Africans by promoting ownership, management opportunities, and skill development within these projects.

Figure 97: Social Equity Norms and Standards

[249] Constitution of South Africa (Section 9)
[250] BBBEE Act 53 of 2003

The Norms governing this landscape are shaped by several pivotal entities, each tasked with a crucial role in ensuring that the energy transition does not just happen but happens right. NERSA regulates tariffs and licenses to ensure affordability and fair access to energy, while the Provincial government works to make renewable energy projects accessible to all citizens, emphasizing equity in job creation and energy access. Meanwhile, entities like the IPPs actively participate in programs that enhance the benefits flowing from these projects to local communities, ensuring that these benefits are integral to the development plans.

Competencies required to navigate and implement this equitable energy landscape include technical skills in renewable energy systems, a deep understanding of equity outcomes essential for what is often referred to as energy democracy, and the ability to foster community engagement. This means not only understanding the technical aspects of energy transitions but also how these transitions impact local communities, ensuring that projects are both inclusive and beneficial.

Supporting these efforts are Development Partners like the United Nations Development Programme and USAID, which provide resources and expertise to integrate social equity into development projects effectively. Traditional authorities and international NGOs such as Oxfam and CARE International play intermediary roles, facilitating dialogue and understanding between communities and project developers. Additionally, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) offers technical support, helping to shape initiatives that are environmentally sustainable and socially inclusive.

6.9 Energy Efficiency Norms and Standards

This strategic approach in Limpopo is more than just a plan for energy efficiency and sustainability; it is a commitment to ensuring that the new energy landscape is built on the foundations of equity and inclusivity, guaranteeing that the benefits of renewable energy advancements reach all corners of the community. This narrative not only outlines the present efforts but also sets a forward-looking path for future developments in Limpopo's renewable energy sector, marking it as a beacon of progress and social equity in energy development.

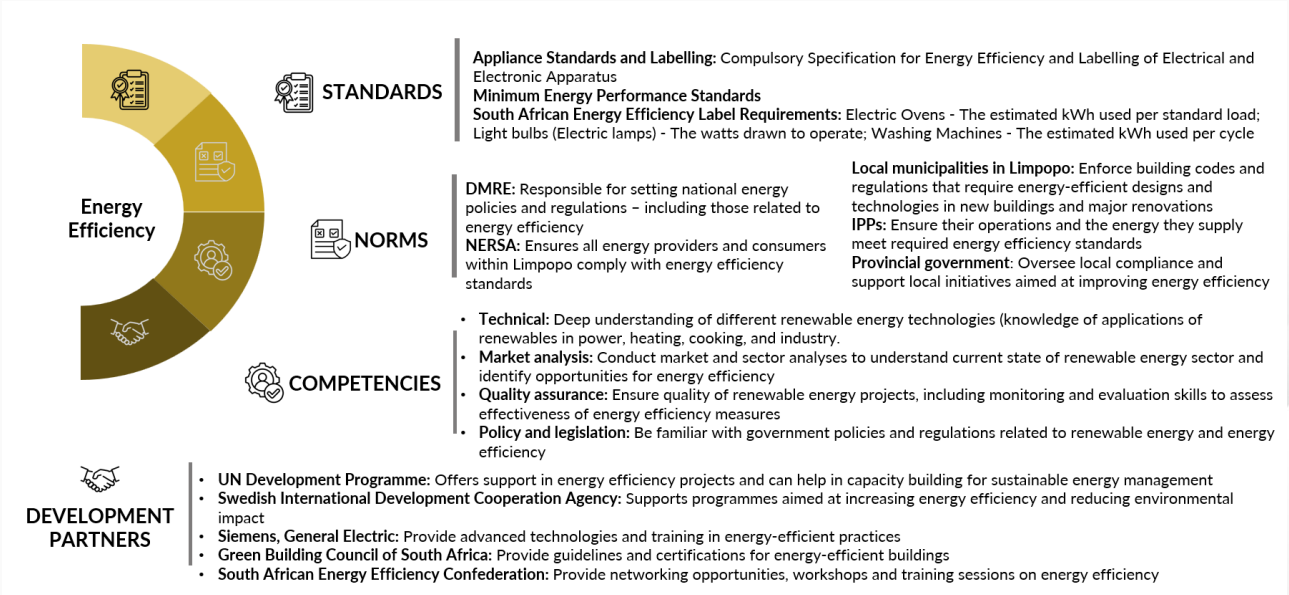


Figure 98: Energy Efficiency Norms and Standards

Standardised appliance labelling empowers consumers to make informed choices, with clear guidelines like kWh usage per cycle for washing machines and wattage for light bulbs. This transparency incentivizes the selection of energy-efficient options. Further solidifying this commitment are established norms that assign clear roles to various stakeholders. The national Department of Mineral Resources and Energy (DMRE) sets the course

with comprehensive energy policies and regulations, while the National Energy Regulator of South Africa (NERSA) ensures compliance within Limpopo's borders. Local municipalities play a vital role by enforcing building codes that necessitate energy-efficient designs and technologies in new constructions and major renovations. Independent power producers IPPs are not exempt, as their operations and energy supply must also meet established energy efficiency standards.

To bolster these efforts, the Limpopo provincial government can foster collaboration with development partners. The United Nations Development Programme offers invaluable support in project development and capacity building for sustainable energy management. Similarly, the Swedish International Development Cooperation Agency provides resources for programs that enhance energy efficiency and lessen environmental impact. Beyond governmental partnerships, collaborations with industry leaders like Siemens and General Electric bring advanced technologies and training opportunities in energy-efficient practices. Additionally, the Green Building Council of South Africa provides crucial guidelines and certifications for energy-efficient buildings, while the South African Energy Efficiency Confederation facilitates networking, workshops, and training sessions, further solidifying the province's commitment to a sustainable energy future. This multi-pronged approach, encompassing clear standards, defined roles, and collaborative partnerships, positions Limpopo as a leader in South Africa's pursuit of energy efficiency.

Phase 3 of the Limpopo Renewable Energy Strategy marks a significant step towards a sustainable and secure energy future for the province. By undertaking the Provincial Energy Needs Assessment, we have gained an in-depth understanding of Limpopo's current energy landscape and its future demands. This data serves as the foundation for the Intervention Strategy. The strategy considers various factors and potential pathways, to achieve Limpopo's ambitious renewable energy goals.

The establishment of Provincial Norms and Standards paves the way for long-term success of the strategy. These standardized guidelines will ensure consistency, quality, and best practices throughout the development, implementation, and maintenance of renewable energy projects across Limpopo. This standardization will not only streamline processes but also attract significant investment, fostering a thriving renewable energy sector within the province, particularly considering Limpopo's existing potential for solar energy production.

The culmination of the Provincial Energy Needs Assessment, Intervention Strategy, and Provincial Norms and Standards represents a cornerstone achievement for the Limpopo Renewable Energy Strategy. These deliverables equip the province with the necessary tools to navigate the transition towards a clean energy future. By embracing renewable energy, Limpopo has the potential to unlock a multitude of benefits. The province can achieve energy security, lessen its environmental footprint, and stimulate economic growth through green job creation and the development of a robust renewable energy industry.

Going forward, successful implementation of the strategy and ongoing monitoring will be of paramount importance. Regular assessments will allow for adjustments to the strategy as needed, ensuring it remains adaptable and responsive to evolving technological advancements and socio-economic conditions. By embracing innovation and fostering collaboration between public and private stakeholders, Limpopo can solidify its position as a leader in South Africa's renewable energy revolution. This leadership will not only benefit the province but also serve as a pillar of inspiration for other provincial governments and regions seeking a sustainable and secure energy future.

7 IMPLEMENTATION ACTION PLAN AND MONITORING & EVALUATION FRAMEWORK

7.1 Introduction

This delves into the critical planning activities required for the Limpopo Renewable Energy Strategy. Following the development of the energy needs assessment and interventions strategy, this phase focuses on translating those plans into actionable steps. Core activities included crafting an Implementation Action Plan, meticulously outlining the specific actions, timelines, and resource allocation required for successful execution.

To ensure ongoing assessment and course correction, a Monitoring and Evaluation Framework was also established. This framework will systematically track progress towards established goals and measure the overall effectiveness of the strategy. Recognizing the importance of long-term success, Phase 4 further addressed the issue of sustainability through the development of an Institutionalisation and Collaborative Governance and Capacity Building Framework. This framework outlines strategies for seamlessly integrating the plan within the organizational structure, fostering a culture of collaboration, and ensuring the ongoing development of capabilities necessary for sustained implementation.

The strategy outlines three strategic outcomes for the province (Figure 99). Economic Development as the key driver, aiming to transform and modernize the provincial economy with Just Energy Transition as a supporting driver that works in tandem with economic development. The strategy focuses on mitigating climate change and improving the quality of life for Limpopo residents. Additionally, Security of Supply is another supporting driver which aims to ensure a stable supply of energy, which is crucial for both economic development and social change.

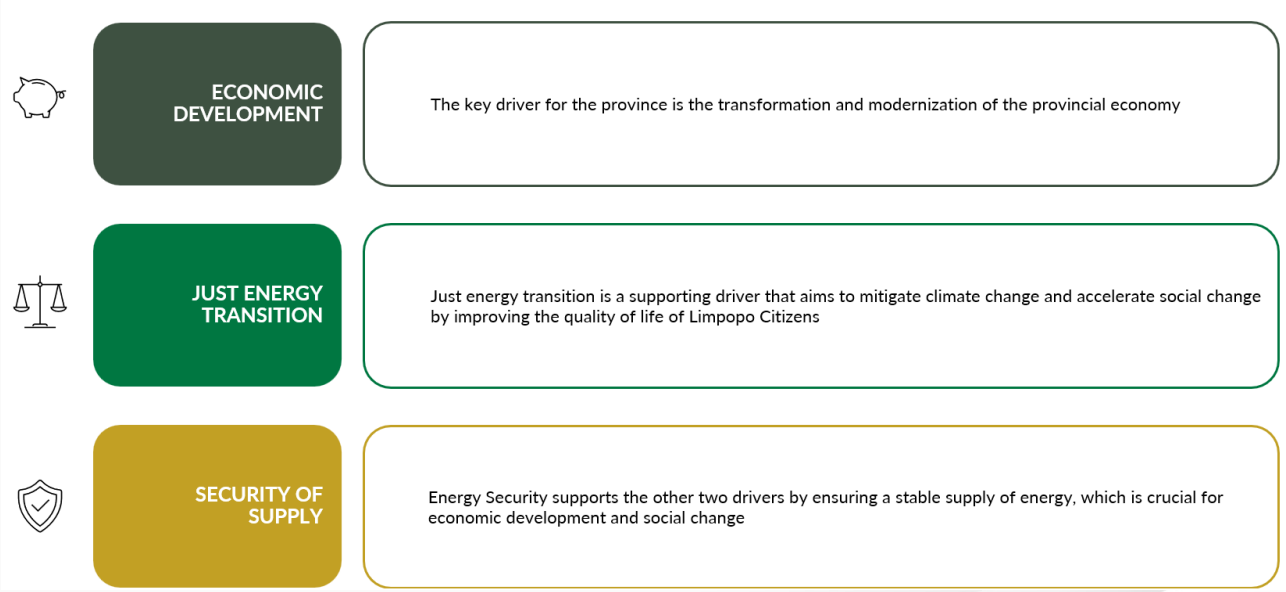


Figure 99: Strategic outcomes

This is supported by the Limpopo Development Plan (LDP) (2020 – 2025)[251] which outlines a variety of mechanisms to improve the current situation (Figure 100). The LDP prioritizes economic transformation and modernization through a three-pronged approach. Firstly, it emphasizes implementing the District Development Model (DDM) to ensure coordinated planning. Secondly, Public-Private Partnerships (PPPs) and targeted support for small businesses will mobilize investment and expertise. Finally, the plan highlights catalytic programs like Special Economic Zones and Science & Technology Parks to drive industrialization with value addition.

The LDP also acknowledges the need for a Just Energy Transition that balances economic development with environmental and social well-being. To achieve this, the plan advocates for skills development programs focused on renewable energy and green technologies. Additionally, it proposes incentives for green investments and stakeholder engagement workshops to foster collaboration within the energy sector.

Lastly, the LDP recognizes the importance of securing a reliable energy supply. This will be achieved by investing in renewable energy projects like wind and solar, while simultaneously exploring energy efficiency opportunities. The plan emphasizes alignment with national energy policies and reducing any regulatory barriers that could hinder renewable energy development and industrialization in the province.

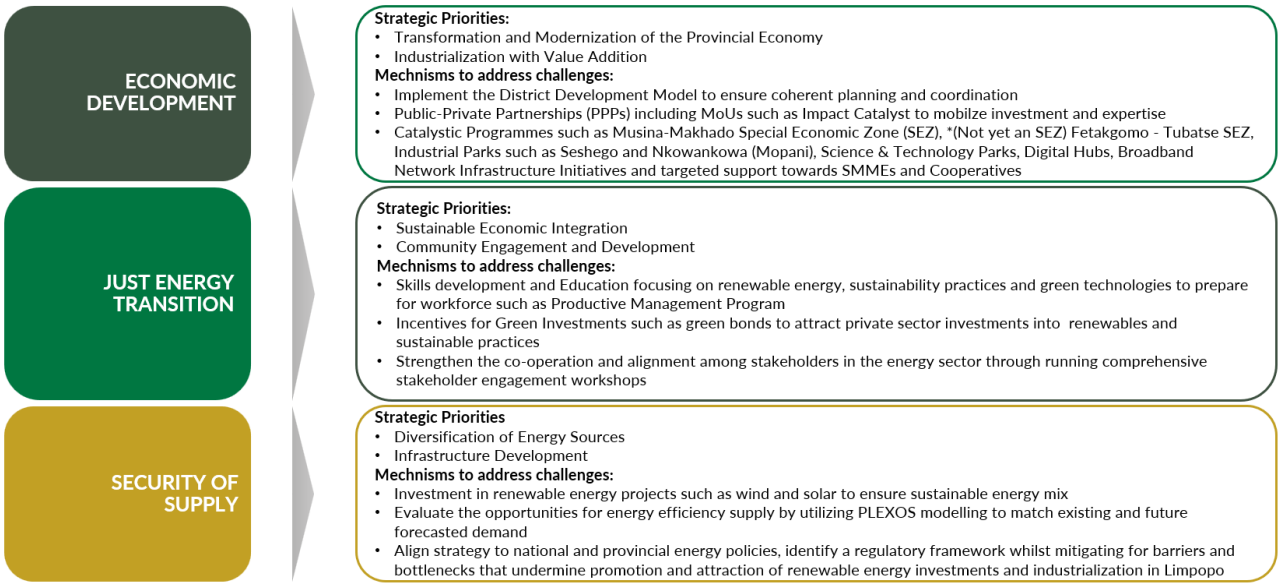


Figure 100:The LDPs strategic priorities and mechanisms to address challenges

The Limpopo Renewable Energy Strategy Framework acts as a central hub, translating its broad strategic goals into concrete actions through a set of key imperatives for each desired outcome (Figure 101). For Energy Security, the focus is on building a robust infrastructure with storage solutions, grid development, and empowering municipalities to participate in energy trading. A Just Energy Transition prioritizes reducing carbon emissions through renewable energy sources, while also emphasizing workforce development in this sector and protecting vital forests. Economic development is driven by innovative financing mechanisms, job creation throughout the renewable energy value chain, and ensuring alignment with the existing local economy. Finally, collaborative governance and capacity building are fostered through collaboration and sector enablement at a provincial level, efficiency and effectiveness at a municipal level, as well as technical and functional competence at a community-based level to raise awareness and build expertise. This comprehensive framework ensures all aspects are addressed, working together to achieve a sustainable energy future for Limpopo.

[251] Limpopo Development Plan (2020 - 2025)

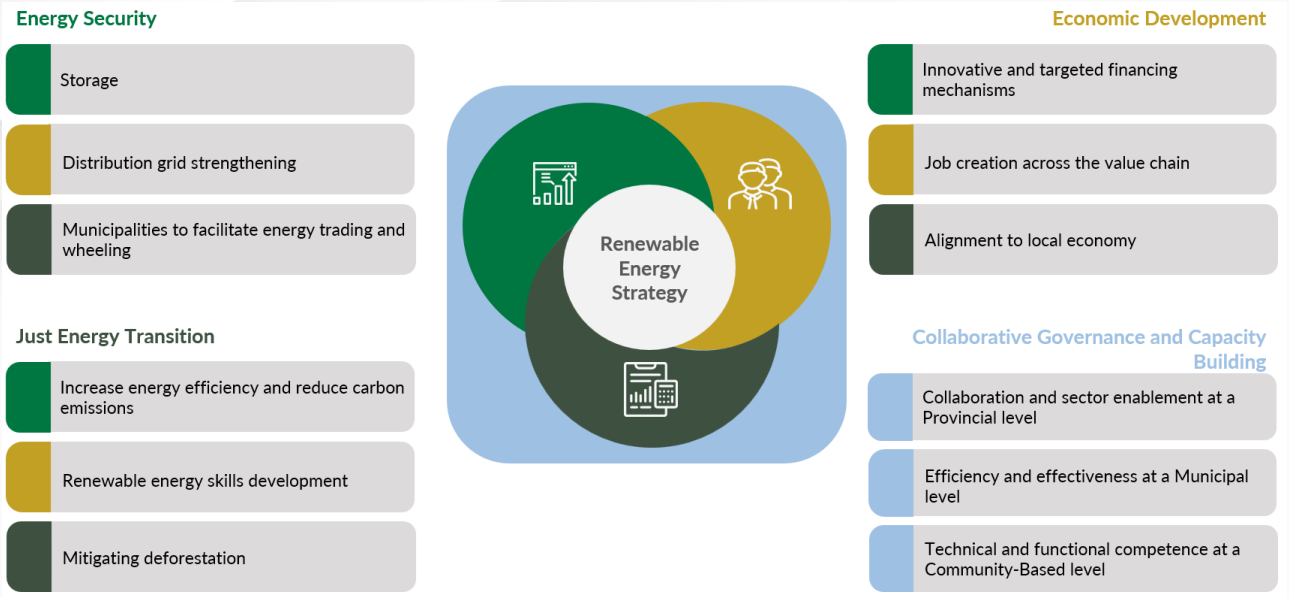


Figure 101: Key imperatives of the strategic outcome

Figure 102 outlines the strategic prioritization framework for achieving key milestones. The framework leverages a two-dimensional matrix to categorize tasks based on their urgency and impact. High impact, high urgency tasks sit at the forefront, demanding immediate attention due to their critical influence on project success. For example, securing financing and finalizing key contracts fall into this category. High impact, low urgency tasks ensure momentum is maintained through activities like stakeholder engagement. While important, they don't directly impact core project functionality. The bottom right quadrant houses low impact, high urgency tasks such as industry analysis with low impact, low urgency, tasks such as policy development, training programs and monitoring and evaluation. This framework allows renewable energy developers to effectively allocate resources, focusing on critical activities that drive progress while ensuring long-term project success.

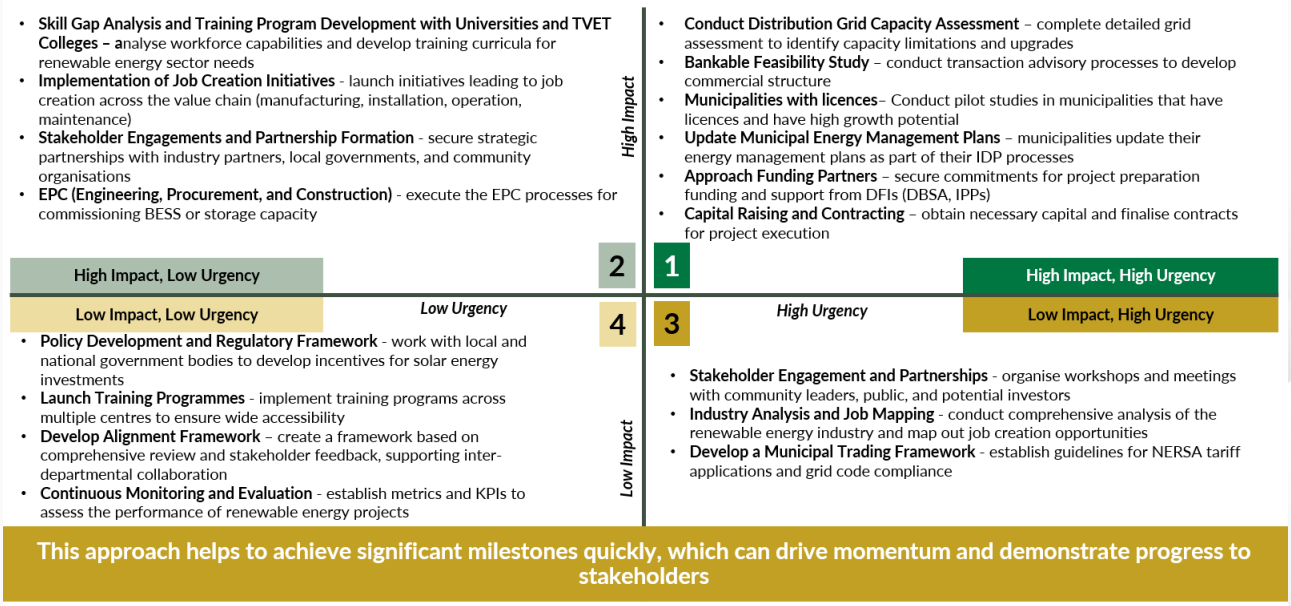


Figure 102: Priority matrix for various tasks

To expedite the implementation of renewable energy initiatives, a multi-pronged approach is recommended (Figure 103). Public awareness campaigns utilizing social media, local media and community events can garner support and participation. Collaboration is key, therefore coordinating with contractors and stakeholders ensures projects are executed promptly. Analysing data will pinpoint skill shortages within the renewable energy sector, allowing for targeted training programs. Funding is crucial, so reaching out to potential partners and arranging meetings to discuss collaboration is essential. Finally, integrating renewable energy goals into existing energy management plans, along with scheduled stakeholder meetings, will ensure alignment and facilitate progress.

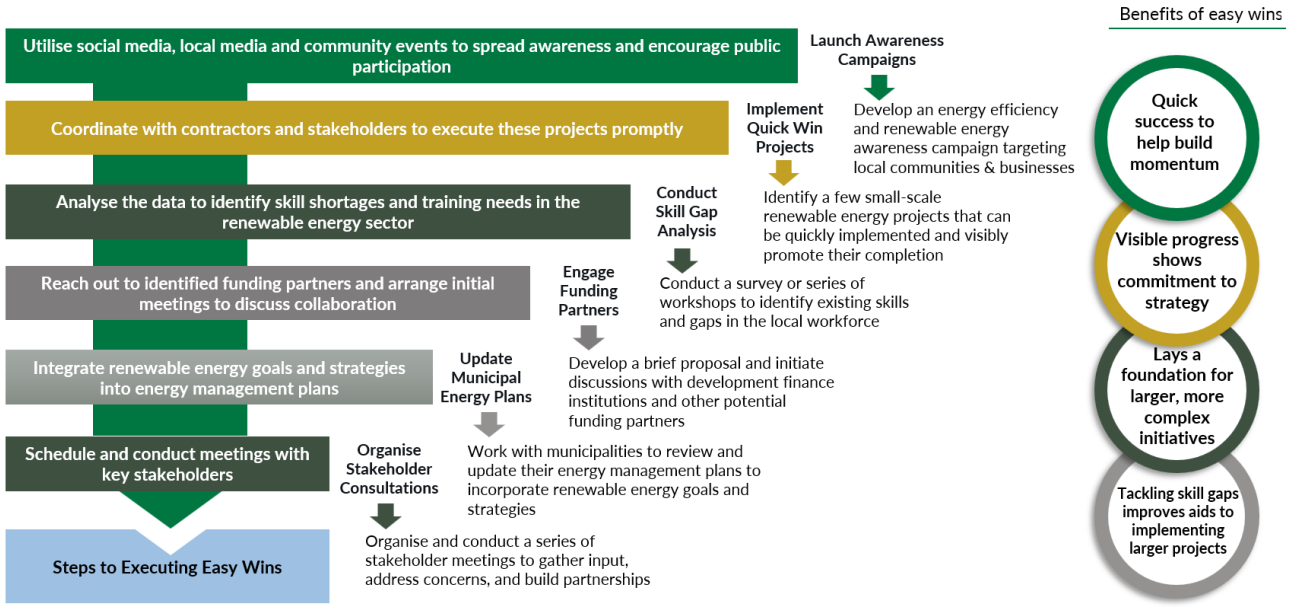


Figure 103: Implementation plan for easy wins

7.2 Energy Security Initiatives and Action Plan

The initiatives are categorized into four strategic areas: Energy Storage, Grid Modernization and Wheeling and Enabling Municipalities to Facilitate Wheeling and Trading (Table 6). The most significant expense lies in Battery Energy Storage, with phased installations reaching 600MW by 2030 at an estimated R8.9 billion to R13.7 billion annually. Grid upgrades and a monitoring system for 2400MW of renewable energy integration come at a cost of R178 million to R445 million with municipal wheeling costs to be determined on a project-by-project basis. More details can be found in Annexure B and C.

Imperative	Baseline	Target State	Cost	Potential Stakeholders	Target Audience
Storage	• No storage, limited storage capacity to support generation capacity and load requirements	• 600MW of BESS by 2030 • 100MW installation per annum starting from 2025	• Approximately between ~R8.9B and R13.7B annually for 100MW installations – • An approximate total of R53.4B and R82.2B	• OEMs (Original Equipment Manufacturer) • Project developers • Energy modelling • Transaction advisers • Private enterprises • CoGHSTA	• Municipalities
Grid Monitoring & Development	• As per GCCA 3360MW grid capacity up to 2025 factoring the 930MW of IPPs coming online then	• By 2030, integrate at least 2400 MW of new renewable generation capacity into the provincial grid, with a comprehensive monitoring system established by 2028 to ensure continuous grid stability and efficiency	• Approximately between R178M and R445M of Total Project management and Other Costs (2-5% of CAPEX)	• OEMs • Project developers • Energy modelling • Transaction advisers • Private enterprises • CoGHSTA • Grid Accessors	• Municipalities
Municipalities to Facilitate Wheeling	Limited wheeling due to: • Most Municipalities cannot wheel due to being in debt to Eskom • Need to have a distribution licence	Unconstrainted wheeling environment by: • End of 2030 Unlicenced Municipalities to be licenced • End of 2030 eliminate Eskom indebted Municipalities	• Cost (OPEX and CAPEX) determined on a case-by-case basis based on individual Municipality status in terms of licencing and debt	• NERSA • Eskom • Provincial Treasury • Advisory services • CoGHSTA	• Municipalities • IPPs • Large scale-consumers (>1kV)
Municipalities to Facilitate Energy Storage and Distribution	Low to limited trading by Municipalities due to: • Need to have a distribution licence • Limited or non-exist capabilities to trade power	Unconstrainted trading environment by: • End of 2030 Unlicenced Municipalities to be licenced	• Cost (OPEX and CAPEX) determined on a case-by-case basis based on individual Municipality status in terms of licencing and debt	• NERSA • Eskom • Provincial Treasury • Advisory services • IPPs • CoGHSTA	• Municipalities

Table: 6 Energy Security initiatives

The action plan incorporates various activities, including the development of a provincial wheeling policy, which would govern the transmission of electricity within the province (Figure 104). Additionally, it emphasizes the creation of a framework for municipal trading, allowing municipalities to buy and sell energy more efficiently. To ensure informed decision-making, the plan highlights the importance of conducting pre-feasibility studies to assess the viability of potential energy projects. Furthermore, it underscores the need for updated municipal energy management plans, which would provide a localized strategy for reducing energy consumption and optimizing energy use within each municipality. An activity and detailed action plan can be found in Annexure B and C, respectively.

Activities	Storage	Grid Monitoring & Development	Municipalities to Facilitate Wheeling	Municipalities to Facilitate Energy Storage and Distribution
Activity 1	Pre-feasibility study - energy modelling	Conduct distribution grid capacity assessment	Review debt obligations with Eskom	Build a municipal trading framework
Activity 2	Update municipal energy management plans	Update municipal energy management plans	Develop mitigating interventions for debt obligations	Develop a trading policy
Activity 3	Approach funding partners	Approach funding partners	Create a wheeling process document	Choose a trading tariff
Activity 4	Bankable feasibility study	Bankable feasibility study	Develop a wheeling policy	Update billing system to implement the settlement calculations
Activity 5	Develop commercial structure	Develop commercial structure	Facilitate wheeling agreements	Create awareness for embedded generators
Activity 6	Capital raising and contracting	Capital raising and contracting	Update billing system to implement the energy settlement calculations	Implement the trading market
Activity 7	Engineering, procurement and construction	Engineering, procurement and construction	Implement wheeling service	-
Activity 8	Continuous operation	Continuous operation	Continuous management of wheeling service offering	Continuous management of the trading system

Figure 104: Overview of action plan to achieve energy security

Achieving energy security requires a collaborative effort across various stakeholders. Figure 105 indicates the roles and responsibilities of various stakeholders with respect to storage, distribution and grid strengthening as well as those responsible to assist municipalities in facilitating energy trading and wheeling.

Energy Security

Storage

- LEDET – environmental regulations, incentives ad subsidies
- NERSA - regulation and licensing
- DMRE - policy and planning
- FTSEZ – manufacturing and assembly
- Local Municipalities – operation and maintenace
- OEM – battery technology development and manufacturing
- Project developers – project planning and design, feasibility studies
- Transaction advisory - assist project developers in navigating financial aspects of storage projects
- Private enterprises – invest in, develop, or operate battery storage facilities
- CoGHSTA – support community-based storage initiatives

Distribution & Grid Strengthening

- Eskom - distribution network management, grid infrastructure development, grid connection
- Limpopo Provincial Government -facilitate renewable energy development, advocacy for provincial grid investment
- NERSA – regulations and standards, licensing and grid access, tariffs
- DMRE – grid planning, policy, facilitate grid investment
- Project developers - feasibility studies, manage the construction process
- Energy modelling – analyse different scenarios

Municipalities to facilitate energy trading and wheeling

- Local Municipalities - grant access to distribution networks and develop wheeling tariffs
- Energy Trading Companies (POWEREX) - facilitate the buying and selling of electricity
- IPPs - sell the electricity they generate to municipalities or other buyers through wheeling agreement
- FTSEZ - attract businesses and IPPs
- SALGA - provide resources and advocate for policies that make energy trading and wheeling more accessible and attractive for municipalities
- NERSA - regulation and licensing
- DMRE - policy development and facilitation

Figure 105: Roles and responsibilities regarding energy security initiatives

7.3 Economic Development Initiatives and Action Plan

The economic development program aims to introduce new financing mechanisms for municipalities by the end of 2025 (Table 7). These mechanisms are expected to cover at least 30% of total project funding, reducing reliance on grants and stabilizing funding sources. The program emphasizes leveraging credit solutions, project finance, and other municipal borrowing options within the framework set by the Policy Framework for Municipal Borrowing. This strategy is expected to create new jobs in construction, operation, and maintenance across the renewable energy value chain. The Limpopo Province itself holds potential for mineral resource contributions to the supply chain, with most job opportunities anticipated in renewable energy system installation and operation. More details can be found in Annexure B and C.

Imperative	Baseline	Target State	Cost	Potential Stakeholders	Target Audience
Innovative and Targeted Financing Mechanisms	• Electricity supply is financed through Municipality distribution margins and grant allocations such as Municipal Infrastructure Grants (MIGs)	• Implement at least 3 new financing mechanisms (e.g., credit solutions, project finance) by end of 2025 • Reach 30% of project funding from these sources	• OPEX cost the time and effort to discuss and generate the required financing agreements	• DFIs • Commercial banks • Provincial Treasury • Transaction advisory • CoGHSTA	• Municipalities
Job Creation Across the Value Chain	• Limpopo produces some of the minerals that feed into the supply chain, but there is limited manufacturing in the space and most job opportunities are in the installation and operation of renewable systems	Job creation: Solar: • 2 728 Direct Construction Jobs • 1 183 Operation and Maintenance FTE Jobs BESS: • 691 Direct Construction Jobs • 1 596 Induced Jobs	• Approximately between R178M and R445M for O&M of BESS • R240m and R600M for O&M of Biodigesters (2 - 5% of CAPEX)	• LEDET and its agencies • Academic institutions • SEDA • Municipalities (economic development and infrastructure functions) • CoGHSTA • National Democratic Institute (NDI)	• Limpopo population • Businesses in Limpopo • IPPs • Municipalities
Alignment to Local Economy	• Currently, there are various programs and initiatives happening at a Provincial level that are not really aligned	By the end of each quarter of 2025 and in each succeeding year, realign across all MMSEZ industries of Energy and Metallurgy, Agro-Processing, Logistics and General Manufacturing to compliment renewable energy value chain	• OPEX facilitation cost	• LEDET and its agencies • CoGHSTA	• SEZs (FTSEZ and MMSEZ) • Private enterprises

Table 7 Economic Development initiatives[252,253]

The economic development action plan emphasizes coordination between various steps, such as industry analysis and training program development (Table 8). The first activity involves a feasibility study and the

[252] CSIR Socio-economic benefits of renewable and storage technologies in South Africa
[253] Musina-Makhado Special Economic Zone (MMSEZ)

selection of financing mechanisms. This is followed by industry analysis and job mapping, which helps identify the skills needed for jobs in specific industries. Then, stakeholders are engaged to develop training programs in collaboration with universities and vocational training institutions (TVET). Following these steps is stakeholder engagement and partnership formation to create a framework for aligning job creation initiatives with the needs of the local economy. The next phase involves implementation and launch, including the rollout of the job creation initiatives and testing the alignment framework on pilot projects.

Monitoring and evaluation are then conducted to assess the effectiveness of the programs. This information is used to inform further scaling of successful initiatives. The final steps include continuous monitoring and evaluation, which ensures the ongoing effectiveness of the implemented programs. This may involve updating the financing mechanisms and skill requirements as needed. An activity and detailed action plan can be found in Annexure B and C, respectively.

Activities	Innovative and Targeted Financing Mechanisms	Job Creation Across the Value Chain	Alignment to Local Economy
Activity 1	Feasibility study and selection of financing mechanisms	Industry analysis and job mapping	Comprehensive review of existing initiatives
Activity 2	Develop implementation strategies	Skill gap analysis and training program development with Univen and TVET	Stakeholder engagement
Activity 3	Stakeholder engagement and partnerships	Stakeholder engagements and partnership formation	Develop alignment framework
Activity 4	Implementation and launch	Implementation of job creation initiatives	Test alignment framework on pilot projects
Activity 5	Monitoring and evaluation	Monitoring, evaluation, and scaling	Training and capacity building
Activity 6	-	-	Implementation across all projects
Activity 7	-	-	Continuous monitoring and evaluation
Activity 8	Continuous monitoring and updates, if need be, of financing mechanisms	Continuous monitoring and updates, if need be, of skill requirements	Continuous M&E of alignment framework for provincial initiatives

Table 8 Overview of action plan to achieve economic development

Figure 107 indicates the roles and responsibilities of the main stakeholders required for innovative and targeted financing mechanisms, to create jobs across the value chain and those responsible for aligning initiatives to the local economy.

Figure 106 Roles and responsibilities regarding economic development initiatives

7.4 Just Energy Transition Initiatives and Action Plan

A key focus of the Just Energy Transition Framework is on reducing greenhouse gas emissions and air pollution (Table 9). The framework outlines a target of achieving a 19% reduction in reliance on the grid by 2030, supported by the development of renewable energy sources. This transition is expected to be facilitated by a solar build rate of 400MW per annum in Limpopo. The framework also emphasizes the importance of addressing the socioeconomic impacts of the transition. By upskilling the unemployed youth in the province and creating new job opportunities in renewable energy sectors, the Just Energy Transition Framework aims to ensure an inclusive and just transition for all. More details can be found in Annexure B and C.

Imperative	Baseline	Target State	Cost	Potential Stakeholders	Target Audience
Reduce Carbon Emissions in Electricity Generation Mix	• Fully reliant on the grid with Limpopo having its share on CO2 emissions from fossil fuel sources	19% target of reduced reliance on the grid by 2030 would lead to: • Low performance coal fleet = 0.105 tCO2/MWh. • High performance coal fleet = 0.127 tCO2/MWh.	• OPEX facilitation cost	• LEDET and its agencies • CoGHSTA	• Municipalities
Renewable Energy Skills Development	• Limited skills in the sector	Upskill of the unemployed youth and launch the training program by 2025 to complete the job-years target by 2030	• Approximately between R11.86 - 29.66M for O&M of BESS • Approximately R16M - 40M for O&M of Biodigesters (1% of workers' pay which only covers 15% of training)	• Department of Basic and Higher Education • Funding Agencies • Private Enterprises • IPPs • Skills Development Fund • Sector Education Training Authorities	• Limpopo labour force • Limpopo academic institutions"
Mitigating for Deforestation	• 3.2TWh of equivalent power is being used by firewood users currently - 2024	By 2030, reduce firewood use to 2.087 TWh, fully replacing this amount with energy produced by biodigesters. Implement measures including the installation of 553,898 biodigesters to be installed for the 276,949 households using firewood, securing necessary funding by 2025-26, and establishing partnerships with local communities and energy companies by 2026.	• Approximately R12B - 12.5B total (Based on retail pricing. There is potential for lower rates through wholesale pricing)	• LEDET and its agencies • Local communities • NGOs • Academic research institutions • Private sector • Commercial Forestry and Agricultural Enterprises	• Limpopo population

Table 9 Just Energy Transition initiative

The eight activities outlined to achieve a just energy transition focuses on renewable energy development, skills development, deforestation mitigation, and emissions reduction in the electricity generation mix. The first activity involves developing a policy and regulatory framework to support the transition. This is followed by industry analysis and job mapping to identify the skills required for new green jobs. Next, feasibility studies and planning are conducted to assess the viability of renewable energy projects. Stakeholder engagement and partnership formation are then undertaken to bring together relevant actors and secure funding for the initiatives. The implementation phase includes monitoring infrastructure upgrades, launching training programs, establishing apprenticeship and internship opportunities, and installing biodigesters.

Continuous evaluation and program adaptation are conducted throughout to ensure the effectiveness of the programs. This includes monitoring and evaluation of CO2 emissions, the power mix, training programs, apprenticeship and internship placements, and firewood use within the province. The findings are used to inform adjustments to the programs as needed. The final activity involves promoting and advocating for renewable energy careers to raise awareness and encourage participation in the green economy. An activity and detailed action plan can be found in Annexure B and C, respectively.

Activities	Reduce Carbon Emissions in Electricity Generation Mix	Renewable Energy Skills Development	Mitigating for Deforestation
Activity 1	Policy development and regulatory framework	Industry analysis and job mapping	Feasibility study and planning
Activity 2	Monitoring IPP solar installations and embedded generation	Skill gap analysis and training program development with Univen and TVET	Policy development and regulatory approval
Activity 3	Monitor infrastructure upgrades and integration initiatives	Stakeholder engagements and partnership formation	Partnership development and funding acquisition
Activity 4	Monitoring and adjustments	Launch training programs	Infrastructure and workforce development
Activity 5	-	Establish apprenticeship and internship opportunities	Biodigester installation and commissioning
Activity 6	-	Continuous evaluation and program adaptation	Monitoring and maintenance
Activity 7	-	Promote and advocate for renewable energy careers	-
Activity 8	Continuous M&E of CO2 emissions and the power mix going forward	M&E of training programs, tracking progress of apprenticeship & internships	M&E of firewood use within the province, coupled with training and maintenance

Table 10 Overview of action plan to achieve a just energy transition

The just energy transition involves initiatives that aim to reduce carbon emissions, development renewable energy skills and assist in mitigation deforestation. The roles and responsibility of the various stakeholders are indicated in Figure 109.

Just Energy Transition

Reduce carbon emissions in electricity generation mix

- Eskom – include more renewables in the energy mix
- Renewable energy companies (IPPs and entities such as Pele Green Energy) - Develop, build, and operate renewable energy facilities
- Provincial Government - Sets provincial development goals that might prioritize clean energy adoption
- LEDET - Support and promote renewable energy development
- CoGHSTA - support community-based renewable energy initiatives

Renewable energy skills development

- Limpopo Department of Education (LDE) - Curriculum development
- TVET Colleges and Universities - offer vocational training programs
- USAID - provide funding or partner with local institutions to develop renewable energy training programs
- Incubator Hubs - provide support and resources to develop innovative solutions

Mitigating deforestation

- SANParks - implements conservation measures
- LDARD - develop and enforce policies related to forestry management
- Environmental NGOs (Mvula Trust) - raise awareness, promote tree-planting initiatives and collaborate with local communities
- UNIVEN and University of Johannesburg - conduct studies on the impact of deforestation, develop new technologies for reforestation efforts, educate future generations

Figure 107 Roles and responsibilities regarding just energy transition initiatives

8 INSTITUTIONALISATION, COLLABORATION GOVERNANCE & CAPACITY BUILDING FRAMEWORK

8.1 Introduction

The Capacity Building Framework outlines a three-tiered approach to building capacity to improve the strategic, regulatory, and technical conditions necessary for establishing a renewable energy strategy in Limpopo (Figure 111). The framework identifies strategic outcomes at each level. Strategic outcome 1 focuses on the Provincial level, aiming to establish a formal platform for collaboration and coordination, a central platform for data analysis to inform policy decisions, and a comprehensive investment framework. Strategic outcome 2 targets the Municipal Level, where the objectives are to leverage technological solutions for policy development, optimize organizational processes for infrastructure development and develop formal communication structures. Strategic outcome 3 addresses the Community-Based Level, aiming to enhance strategic leadership and strategy development, policy development capability, and fundamental competencies for sector enablement. These outcomes are supported by Strategic Objectives that outline specific actions to be taken at each level.

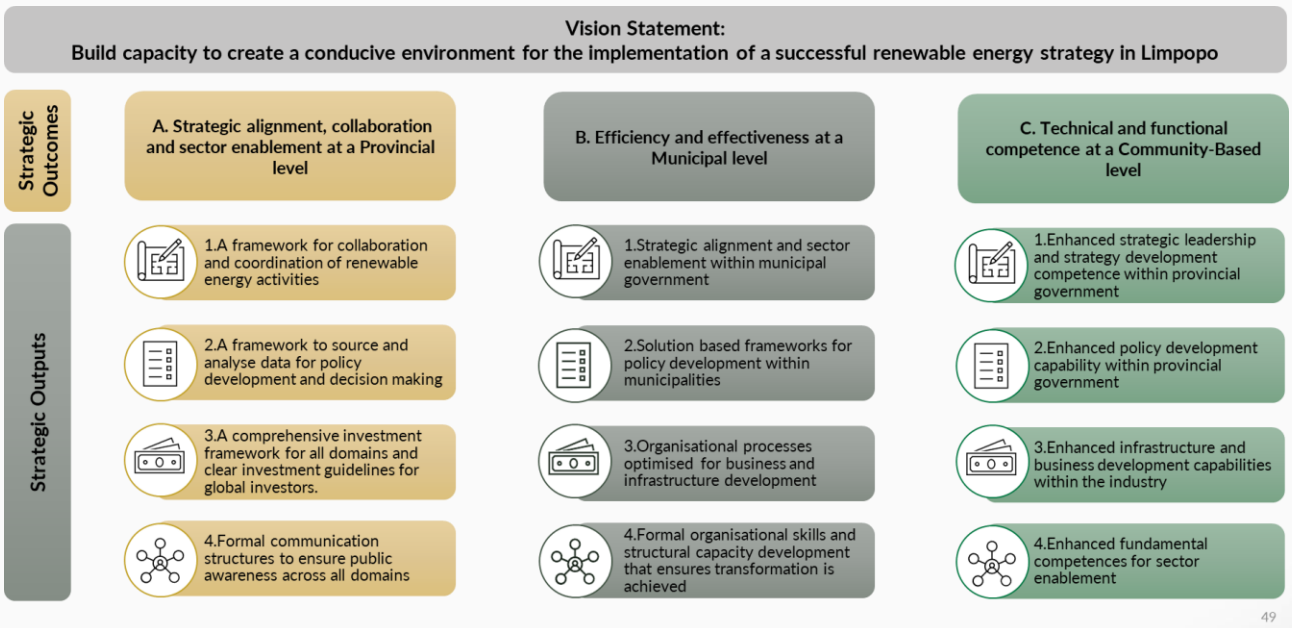


Figure 108: Strategic outcomes and outputs

8.2 Strategic Interventions

8.2.1 Provincial level

The strategic interventions at provincial, municipal and community-based level are depicted in Figure 112 and 108. Provincial level interventions focus on advanced training programs for government officials, public-private partnership development, and infrastructure development support. This includes specialized training on renewable energy policy, project management, and environmental assessments. Additionally, the program aims to foster public-private partnerships to leverage private sector expertise and resources and support the development of infrastructure to integrate renewable energy sources into the existing power grid.

Additionally, provincial interventions focus on stakeholder engagement, renewable energy research and innovation hubs, and digital transformation and technological integration. Stakeholder engagement includes

organizing regular meetings to ensure policy alignment and address concerns and training municipal officials in financial planning specific to renewable energy projects. Research and innovation hubs will be established to support ongoing research in renewable energy technologies and applications. The program will develop robust data management systems to collect and analyse data from renewable energy operations and integrate necessary technology and infrastructure to support the integration of renewable energy solutions.

8.2.2 Municipal level

Municipal level interventions target training and education programs for municipal staff and local leaders, as well as technical assistance and advisory services. Training programs will focus on renewable energy technologies and grid integration, while technical assistance will provide ongoing support for municipalities in areas like renewable energy planning, project implementation, and regulatory compliance. The program also aims to establish collaboration and networking platforms for municipalities to share insights on renewable energy projects.

Municipal interventions target policy development workshops, community engagement and public education, and renewable energy incubator programs. Workshops will be aimed at helping municipalities understand and influence renewable energy policies. Community engagement efforts will focus on promoting renewable energy benefits through educational campaigns and participatory planning. The program will also establish incubator programs specifically designed to nurture and support local entrepreneurs and startups focused on renewable energy innovations.

8.2.3 Community level

Community-based level interventions include community renewable energy training programs, local renewable energy cooperatives, and community grants and funding access. Training sessions will be developed to educate community members on the basics of renewable energy technologies and how they can participate in renewable energy projects. The program will also support the formation and operation of community-led renewable energy cooperatives and provide information and assistance to communities for accessing grants and funding for developing local renewable energy projects. Public awareness campaigns will be conducted to educate communities on the importance of renewable energy, energy conservation practices, and the potential benefits of the program.

Community-based interventions include youth and women's leadership programs, technology access and infrastructure development and digital literacy and technology access programs. Special programs will be designed to engage youth and women, empowering them with leadership roles and decision-making positions in local renewable energy initiatives. The program will facilitate access to technology and infrastructure that supports the integration of renewable energy solutions to community facilities and homes. Additionally, programs will be developed to improve digital literacy among community members, coupled with providing access to digital tools and platforms that facilitate monitoring and management of energy usage.

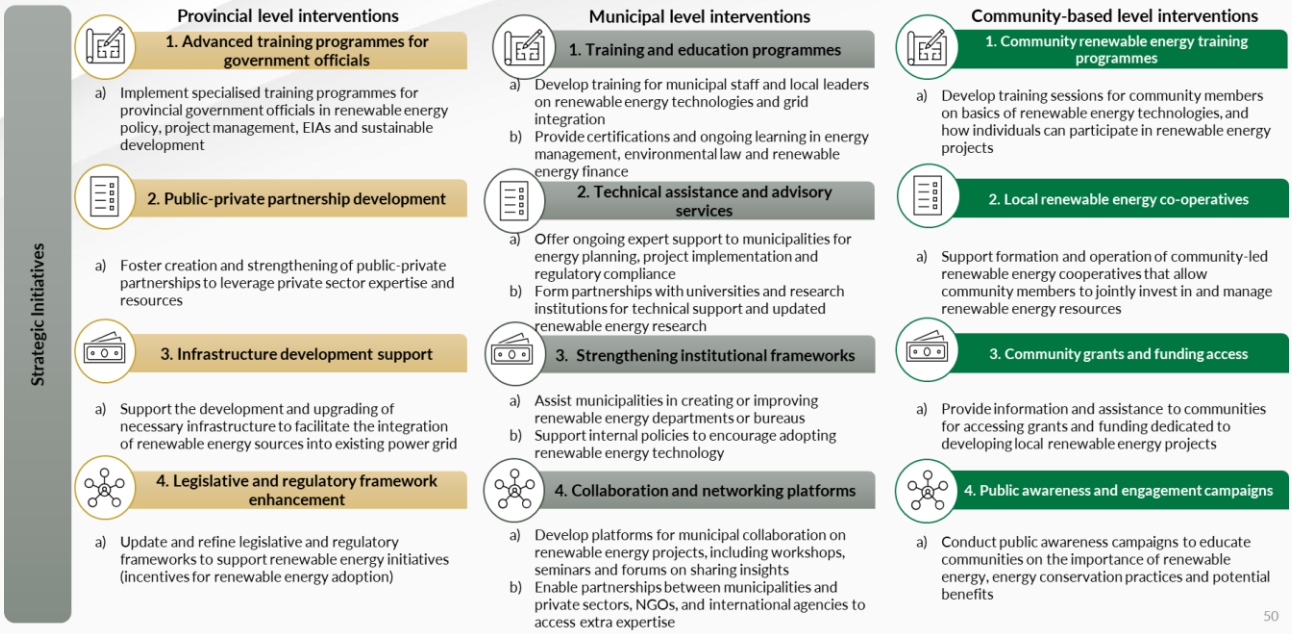


Figure 109: Strategic interventions focusing on collaboration, regulatory and financing frameworks

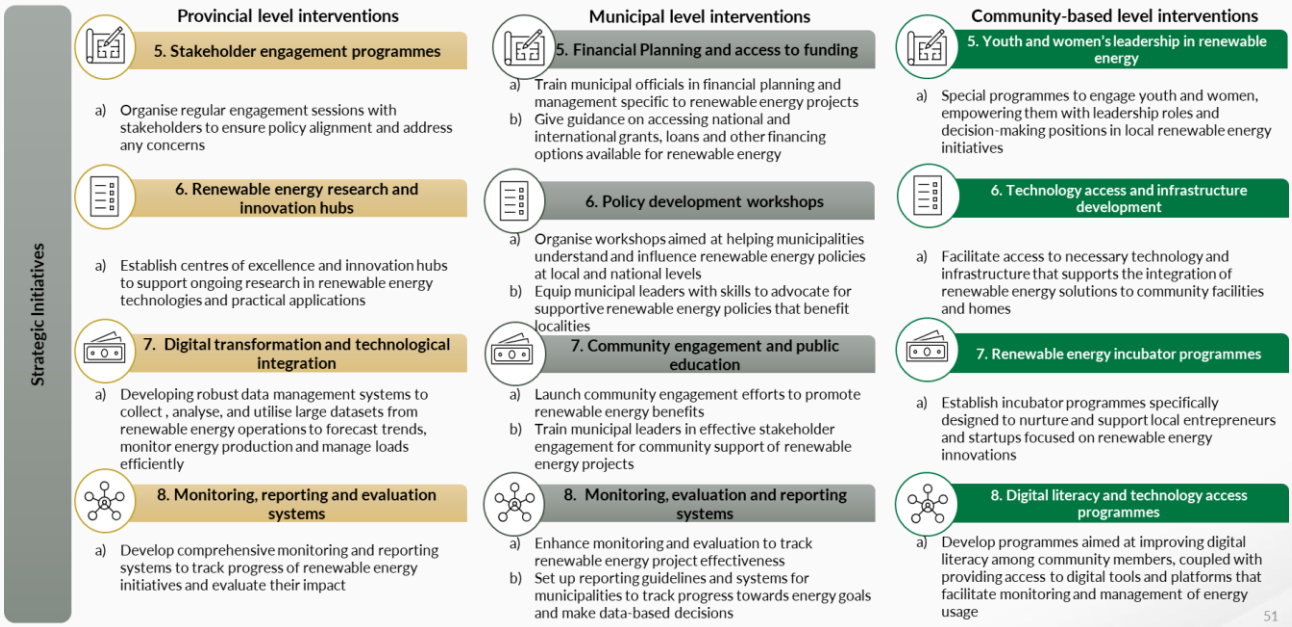


Figure 110: Strategic interventions focusing on stakeholder engagements and support programmes

Collaborative governance and capacity building entails collaboration and sector enablement at a provincial level, efficiency and effectiveness at a municipal level as well as technical and functional competence at a community-base level. The roles and responsibility of the various stakeholders are indicated in Figure 114.

Figure 111 Roles and responsibilities regarding collaborative governance and capacity building

8.3 Strategic Initiatives

8.3.1 Provincial level

At a provincial level, several strategic initiatives are required (Table 11,12). One key pillar involves building government capacity through advanced training programs for officials. This enhanced expertise (Output 1) will streamline project execution and boost success rates. Another pillar focuses on fostering public-private partnerships. By attracting private investment (Output 2), the framework aims to stimulate economic growth across various sectors. Additionally, infrastructure development support is crucial. Upgrading the grid (Output 3) will take years and significant investment to implement (BESS: R8.9-13.7 billion/year, Grid: R178-445 million) but is essential for integrating renewable energy sources. Finally, the framework emphasizes legislative and regulatory improvements. A supportive legal environment (Output 4) will ensure long-term project viability and encourage industry participation.

Strategic Initiative		Timeframe	Cost	Impact	Output
1. Advanced training programmes for government officials	Implement specialized training programs for provincial government officials in renewable energy policy, project management, environmental impact assessments, and sustainable development	3 to 12 months	Such programmes cost between R600,000 to R3M depending on the complexity of the content, the number of participants, etc.	As government officials gain expertise in renewable energy projects, this proficiency will lead to more efficient project execution, fewer delays, and higher success rates in renewable initiatives	**Output 1:** Government officials will have improved capabilities to design, implement, and oversee renewable energy projects effectively
2. Public-private partnership development	Foster the creation and strengthening of public-private partnerships (PPPs) to leverage private sector expertise and resources for renewable energy projects	12 to 24 months	Developing PPPs can range significantly, from R2 - 10M, depending on the scale of the partnerships, legal and consultancy fees, and initial feasibility	This influx of capital not only boosts local businesses involved in renewable energy but also creates jobs and stimulates growth in associated industries such as construction, engineering, and services	**Output 2:** Attract more investment from the private sector, enhancing the scale and scope of renewable energy projects
3. Infrastructure development support	Support the development and upgrading of necessary infrastructure to facilitate the integration of renewable energy sources into the existing power grid	Upgrading existing grids might take 2-5 years, while building new transmission lines for large-scale renewable energy integration could take 5-10 years	BESS: ~ R8.9B and R13.7B annually for 100MW installations Grid: ~R178M and R445M of total project management and other costs (2-5% of CAPEX)	Strengthening the energy infrastructure to support diverse renewable sources lays the foundation for a more stable and sustainable energy supply. It positions Limpopo as a model for renewable energy integration	**Output 3**: This will result in more robust and efficient energy infrastructure capable of integrating diverse renewable energy sources.
4. Legislative and regulatory framework enhancement	Update and refine legislative and regulatory frameworks to support renewable energy initiatives, including incentives for renewable energy adoption and penalties for non-compliance	12 to 36 months	Costs for legislative work could range from R500,000 to R2M – covering expert legal advice, stakeholder consultations, and process of drafting and enacting new laws	Developing a supportive legislative and regulatory framework for renewable energy ensures long-term sustainability of energy projects	**Output 4:** Create a supportive environment for renewable energy growth, ensuring compliance and encouraging industry participation

Table 11 Provincial strategic initiatives

Strategic Initiative		Timeframe	Cost	Impact	Output
5. Stakeholder engagement programmes	Organise regular engagement sessions with stakeholders to ensure policy alignment and address any concerns	This is an ongoing process, but individual programmes or campaigns can range from a few weeks to several months.	R500K – R5M (depending on the scale of the project)	Effective stakeholder engagement can lead to increased support for projects, reduced conflicts, better decision-making, and improved social and environmental outcomes	**Output 5:** A well-informed and engaged group of stakeholders who understand and support the goals of the renewable energy projects
6. Renewable energy research and innovation hubs	Establish centres of excellence and innovation hubs to support ongoing research in renewable energy technologies and practical applications	3-5 years or more	R25M - R2.5B (depending on the scale of the project)	Research and innovation hubs can accelerate the development and deployment of new renewable energy technologies, improve the efficiency of existing technologies, and drive down costs.	**Output 6:** New knowledge, technologies, and innovations that can advance the renewable energy sector and contribute to a cleaner energy future
7. Digital transformation and technological integration	Support the development and upgrading of necessary infrastructure to facilitate the integration of renewable energy sources into the existing power grid	Few months for smaller implementations to several years for large-scale grid modernisation efforts.	R1M - R10M	Digital transformation and technological integration can improve the efficiency, reliability, and resilience of the power grid, enable better integration of renewable energy sources, and empower consumers with more control over their energy usage	**Output 7:** A modernised and intelligent power grid that can accommodate a growing share of renewable energy sources while maintaining stability and security
8. Monitoring, reporting and evaluation systems	Developing robust data management systems to collect , analyse, and utilise large datasets from renewable energy operations to forecast trends, monitor energy production and manage loads efficiently	3-6 months	R100K - R2M	Robust monitoring, reporting, and evaluation systems can provide valuable insights into the performance of renewable energy projects, identify areas for improvement, and inform decision-making	**Output 8: A**ccurate and reliable data, reports, and evaluations that support evidence-based decision-making, continuous improvement, and accountability in the renewable energy sector

Table 12 Provincial strategic initiatives

8.3.2 Municipal level

There is the need for capacity building at the municipal level (Table 13,14). Through training programs, municipal staff will gain the knowledge and skills (Output 1) necessary to manage and implement renewable energy projects effectively. Ongoing technical support will further empower municipalities (Output 2) by establishing dedicated renewable energy departments. These departments will ensure regulatory compliance and manage the complexities of renewable energy initiatives. Furthermore, by strengthening internal policies tailored to each municipality's needs (Output 3), wider adoption and integration of renewable energy solutions will be facilitated. Finally, collaboration platforms will foster partnerships between various stakeholders (Output 4).

Strategic Initiative		Timeframe	Cost	Impact	Output
1. Training and education programmes	Develop comprehensive training programs for municipal staff and local leaders on renewable energy technologies, grid integration, and sustainable energy practices.	12 to 18 months	Typically ranges from R500,00 to R2M, depending on the scope, duration and number of participants	The improved capability in handling complex energy projects can also drive innovation and adoption of advanced technologies, leading to a more sustainable energy landscape in Limpopo.	**Output 1**: Equips municipal staff with knowledge on renewable energy systems, enhancing their capability to effectively implement and manage energy projects.
2. Technical assistance and advisory services	Provide ongoing technical support to municipalities through expert consultations and advisory services. This could include assistance in energy planning, project implementation, and navigating regulatory frameworks.	Ongoing service offered throughout the renewable energy development process (usually provided over the course of a year or more)	Ongoing technical support and consultancy services could cost between R1-3M annually, covering salaries or fees for experts, travel expenses and materials	The creation of specialized energy departments or bureaus within municipalities equips Limpopo to manage its renewable energy initiatives more effectively and ensure greater regulatory compliance.	**Output 2**: Support the development of specialised departments focused on renewable energy, helping municipalities manage and sustain renewable energy initiatives
3. Strengthening institutional frameworks	Support the development of internal policies and procedures that encourage and facilitate the adoption of renewable energy technologies.	6 to 12 months, depending on the complexity and scope of the policies	Development of internal policies and procedures could range from R300,000 to R1M. This includes consultancy fees for policy experts, stakeholder consultation meetings and dissemination of new policies	The development and enforcement of well-crafted local policies tailored to the specific needs and resources of each municipality will promote wider adoption and integration of renewable energy solutions	**Output 3:**Assists municipalities in creating and enforcing policies that promote and regulate the adoption of renewable energy technologies and practices.
4. Collaboration and networking platforms	Facilitate partnerships between municipalities and private sector players, NGOs, and international development agencies to leverage additional expertise and funding.	3 to 6 months, with ongoing operations thereafter. Networking events may occur annually or biannually	Establishing and maintaining such platforms cost between R400,000 to R2M – including setup costs, management of the platform and organisation of networking events	Establishing dynamic partnerships among municipalities, private sector entities, educational institutions, and other stakeholders will create a robust network that leverages collective resources and expertise	**Output 4:** Enhances cooperation and resource sharing between municipalities, private sector entities, and other stakeholders to drive the implementation of joint renewable energy projects.

Table 13 Municipal strategic initiatives

Strategic Initiative		Timeframe	Cost	Impact	Output
5. Financial Planning and access to funding	Train municipal officials in financial planning and management specific to renewable energy projects. Give guidance on accessing national and international grants available for renewable energy	6-12 months	R500K – R1M	Train municipal officials in financial planning and management specific to renewable energy projects. Provide guidance on accessing national and international grants available for renewable energy	**Output 5:** Improved financial management for renewable energy projects, increased access to funding sources
6. Policy development workshops	Offer ongoing expert support to municipalities for energy planning, project implementation and regulatory compliance	3-6 months	R200K – R500K	Offer ongoing expert support to municipalities for energy planning, project implementation, and regulatory compliance	**Output 6:** Enhanced capacity for policy development and implementation in municipalities
7. Community engagement and public education	Train municipal leaders in effective stakeholder engagement for community support of renewable energy projects	6-9 months	R300K – R700K	Train municipal leaders in effective stakeholder engagement for community support of renewable energy projects	**Output 7:** Increased community support and participation in renewable energy projects
8. Monitoring, evaluation and reporting systems	Set up reporting guidelines and systems for municipalities to track progress towards energy goals and make data-based decisions	9-12 months	R400K – R800K	Set up reporting guidelines and systems for municipalities to track progress towards energy goals and make data-based decisions	**Output 8: I**mproved tracking and reporting of renewable energy progress, enabling data-driven decision-making

Table 14 Municipal strategic initiatives

8.3.3 Community level

Community engagement and empowerment alongside infrastructure development is vital. By providing training sessions on renewable energy, the framework aims to cultivate a more informed citizenry (Output 1) capable of making informed decisions about energy use and potentially even participating in renewable energy projects.

Furthermore, the framework encourages the formation of local co-operatives. These community-owned ventures (Output 2) allow residents to directly invest in and benefit from renewable energy resources, fostering local ownership and economic development. To bridge the funding gap, the framework helps in accessing grants empowering communities to secure resources for their projects (Output 3). Finally, public awareness campaigns will be required to be conducted throughout the process (Output 4) (Table 15,16). These campaigns will ensure residents are not only informed about the transition but also actively involved in shaping Limpopo's renewable energy future.

Strategic Initiative		Timeframe	Cost	Impact	Output
1. Community renewable energy training programmes	Develop training sessions for community members on the basics of renewable energy technologies, their benefits, and how individuals can participate in or start renewable energy projects.	On an ongoing basis (each training period lasting from a couple of days up to 3 months)	Approximately R300,000 and R1.5M, covering hiring local experts, venue rental, training materials and possible transportation and accommodation for trainers	Enhanced understanding of renewable energy within communities will lead to a more informed populace that can make educated decisions about their energy consumption and production.	**Output 1:** Government officials will have improved capabilities to design, implement, and oversee renewable energy projects effectively.
2. Local renewable energy co-operatives	Support the formation and operation of community-led renewable energy co-operatives that allow community members to jointly invest in and manage renewable energy resources.	12 to 36 months	Initial setup costs can range from R750,000 over to R5M, depending on the technologies and scale involved (e.g. solar panels, wind turbines).	By fostering local ownership of renewable energy resources through co-operatives, communities not only keep the economic benefits of energy projects within the area	**Output 2:** Attract more investment from the private sector, enhancing the scale and scope of renewable energy projects
3. Community grants and funding access	Provide information and assistance to communities for accessing grants and funding dedicated to developing local renewable energy projects.	3 to 6 months for smaller grants to 12 months or more for larger projects	Administrative costs might range from R450,000 to R2M annually, which includes staffing, promotional activities to inform communities about grants and advisory services to help with grant applications	With better access to grants and funding, communities can develop and manage their renewable energy projects, leading to economic diversification and resilience.	**Output 3**: This will result in more robust and efficient energy infrastructure capable of integrating diverse renewable energy sources.
4. Public awareness and engagement campaigns	Conduct public awareness campaigns to educate communities on the importance of renewable energy, energy conservation practices, and the potential economic and environmental benefits.	Campaigns can vary from 3 months for targeted efforts to ongoing campaigns lasting several years	For smaller, local campaigns, costs might start around R150,000 up to R3M, for larger, more comprehensive including television, radio, online and print media	Effective public awareness and engagement campaigns ensure that the community is not only aware of but actively involved in the planning and implementation of renewable energy projects.	**Output 4:** Create a supportive environment for renewable energy growth, ensuring compliance and encouraging industry participation.

Table 15 Community-based strategic initiatives

Strategic Initiative		Timeframe	Cost	Impact	Output
5. Youth and women's leadership in renewable energy	Special programmes to engage youth and women, empowering them with leadership roles and decision-making positions in local renewable energy initiatives	12 – 36 months	R1M – 2.5M	Increased representation of women and youth in renewable energy decision-making roles, leading to more diverse perspectives, innovative solutions, and greater community buy-in for projects	**Output 5:** A pipeline of skilled and empowered young leaders and women who can drive the growth and sustainability of the renewable energy sector in South Africa
6. Technology access and infrastructure development	Facilitate access to necessary technology and infrastructure that supports the integration of renewable energy solutions to community facilities and homes	36 – 120 months	R100M – R1B	Improved access to reliable and affordable energy in underserved communities, particularly in rural areas. This could lead to improved living standards, and greater social equity	**Output 6:** Robust energy infrastructure that supports the integration of renewable energy sources and enables wider access to clean energy for all South Africans
7. Renewable energy incubator programmes	Establish incubator programmes specifically designed to nurture and support local entrepreneurs and startups focused on renewable energy innovations	12 – 36 months	R500K – R5M	Acceleration of renewable energy innovation and entrepreneurship in South Africa	**Output 7:** A thriving ecosystem of renewable energy startups and entrepreneurs who are developing and commercializing innovative solutions
8. Digital literacy and technology access programmes	Develop programmes aimed at improving digital literacy among community members, coupled with providing access to digital tools and platforms that facilitate monitoring and management of energy usage	1-12 months	R500K - R5M	Empowered communities with the knowledge and tools to monitor and manage their energy consumption effectively	**Output 8:** A digitally literate population that can actively participate in the transition to a clean energy future and contribute to a more sustainable and resilient energy system

Table 16 Community-based strategic initiatives

9 CONCLUSION

The global and national energy landscape is undergoing a significant transformation, with renewable energy playing an increasingly central role. South Africa, with its abundant solar and wind resources, is well-positioned to embrace this shift. The move towards decentralised energy generation and the liberalisation of the energy sector present opportunities for sustainable growth and development. However, this transition also poses challenges, particularly in addressing the social and economic impacts of decommissioning the existing coal fleet.

The Limpopo Renewable Energy Strategy recognises the importance of balancing economic development with environmental sustainability and social equity. It outlines a comprehensive approach to harnessing the province's renewable energy potential while mitigating the negative consequences of the energy transition. This strategy is not merely a response to global trends but a proactive step towards a more resilient, equitable, and prosperous future for Limpopo.

With this strategy, Limpopo can reduce up to 19% reliance on the grid by 2030, along with the benefits of economic development and energy security, demonstrate South Africa's significant potential to fulfil this global objective. While millions worldwide are affected by the climate crisis, the collective push for a sustainable future underscores the crucial role South Africa plays. Limpopo's commitment to diversifying its energy mix not only positions the province prominently on the global stage but also serves as tangible evidence that this commitment is both feasible and achievable.

The Limpopo Renewable Energy Strategy is designed to be adaptable and responsive to an ever-changing environment. This strategy is not a rigid plan but a set of guiding principles and approaches that can be adjusted as circumstances evolve. This flexibility is exemplified by the ongoing debates regarding the extension of the coal fleet beyond 2027. The primary arguments against extending the coal fleet stem from South Africa's commitment to significantly reduce carbon emissions and to recapacitate the generation capacity of its utilities.

Another significant factor influencing the strategy is the recent legal challenges to certain regulations, such as the Electricity Regulation Bill. The South African Local Government Association (SALGA) has taken this legislation to court following changes made during the National Council of Provinces (NCOP) review, specifically concerning electricity distribution, which impacts municipalities.

Given the fluid nature of the regulatory environment and the conflicting policies arising between industrial economic needs and South Africa's commitment to net zero emissions, this strategy must not be viewed as a static document. Instead, it must undergo continuous review and updating to remain relevant and effective.

The robustness of this strategy is validated by its ability to remain effective under various modelled scenarios, reinforcing its credibility and the likelihood of achieving the desired impact and outcomes through the proposed recommendations. The project team based their work on the following assumptions:

1. The province is actively pursuing a more diversified energy mix to ensure a reliable and sustainable power supply. This includes significant investments in solar infrastructure, advanced energy storage technologies, and exploration of biomass energy derived from organic waste.
2. Limpopo Province aims to integrate renewable energy sources across all sectors, targeting a 10% share in the overall energy mix. This transition to sustainable energy is expected to significantly reduce the province's carbon emissions.

Moreover, this strategy requires intensive engagement and support from municipalities, as they are key players in electricity delivery. Municipalities play a crucial role in energy planning, storage, and management, as outlined in the framework they have established. Their involvement is essential to the successful

implementation and adaptation of the Limpopo Renewable Energy Strategy, ensuring it meets both local and national objectives.

ANNEXURE A: STAKEHOLDER ENGAGEMENTS

Stakeholder Engagement

Background

The stakeholder engagements for Limpopo's renewable energy strategy creation were crucial for its success for several reasons. Firstly, the diverse perspectives offered by different stakeholders provide a comprehensive understanding of the potential benefits and challenges associated with renewable energy. Secondly, stakeholder engagement fosters a sense of ownership and commitment, which is essential for the successful implementation of any proposed solutions. Lastly, it ensures transparency and promotes trust among all parties involved, thereby facilitating more effective decision-making processes.

To gather insights from the stakeholders, a systematic methodology was used. We began by identifying stakeholders through stakeholder mapping. Following this, the stakeholders were sent invitations and a day before the meeting agenda was circulated. During the meeting, key actions and points were noted. If stakeholders promised to provide additional documents or data, follow-up actions were taken to ensure these resources were received. This process ensured a comprehensive understanding of all District stakeholder perspectives which contributed significantly to the findings of this report.

Overview of the workshop structure

The workshop employed a well-defined schedule, fostering a collaborative environment for exploring Limpopo's renewable energy transition. The day was segmented into presentations, facilitated discussions, and refreshment breaks. Following introductions and project overviews, a policy analysis of the current energy landscape provided context. A facilitated discussion allowed participants to offer initial feedback on the presented information. With discussions centred around our key core themes as defined by Figure 115 below.

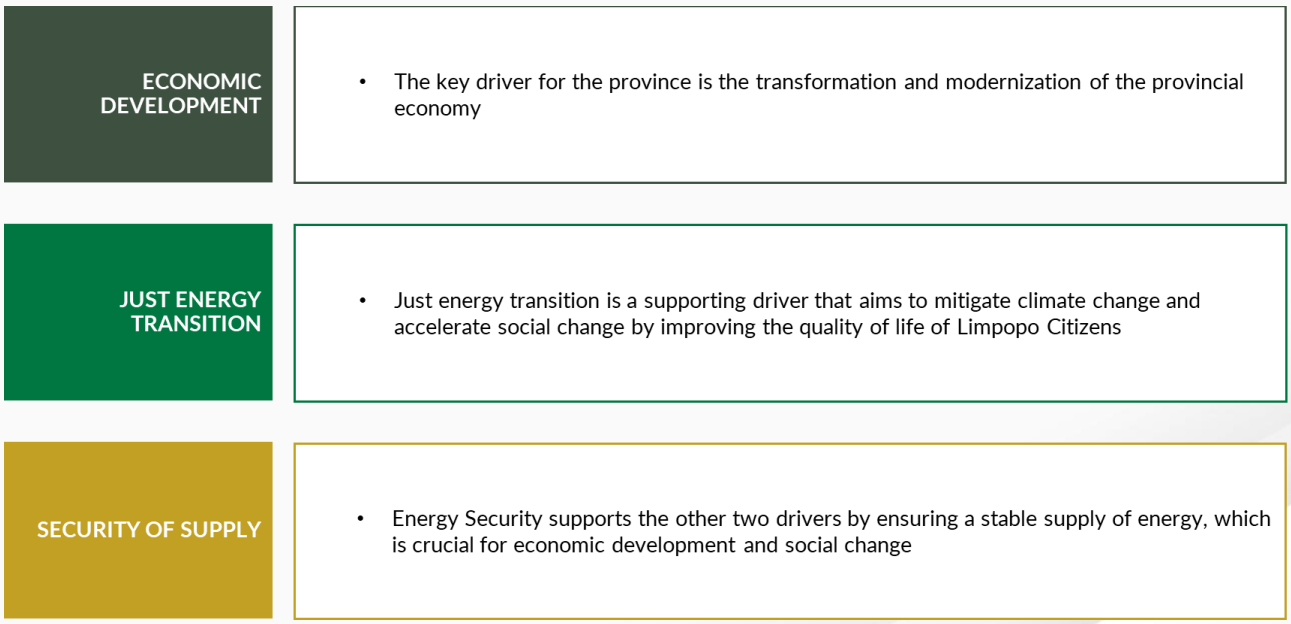


Figure 112: Three core themes

The participants were then divided into groups for the sessions. Each session had different questions, relating to the three themes of energy security, economic development and just energy transition.

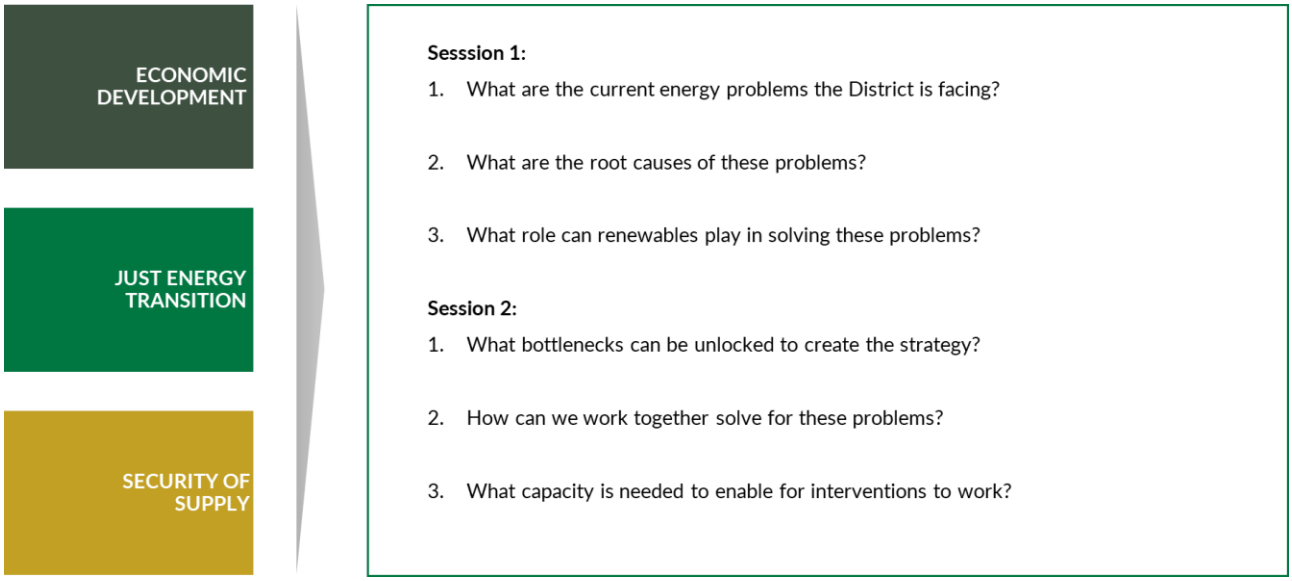


Figure 113: Workshop questions

Following this, each group reported back to the forum on what where the pertaining issues and solutions identified before concluding with open discussion and closing remarks. Strategic placement of refreshment breaks throughout the day ensured sustained engagement from participants.

Time	Item		Structure	Presenter/Facilitator
08:30 – 09:10	Introduction of Project Scope and Key Outcomes		Presentation	Task Team
09:10 – 09:20	Current situation in the Energy Landscape	**Policy Analysis**	Presentation	Task Team
09:20 – 09:30		**District Level Analysis**		
09:30 – 09:40	**Refreshments**			
09:40 – 09:50	Initial feedback from the forum regarding insights shared		Facilitated discussion	Task Team
09:50 – 10:20	**Session 1:** Individual commission discussion	Energy Security	Facilitated discussion	
10:20 – 10:50		Just Energy Transition		Task Team
10:50 – 11:20		Economic Development		
11:20 – 11:30	**Refreshments**			
11:30 – 12:00	**Session 2:** Individual commission discussion	Energy Security	Facilitated discussion	Task Team
12:00 – 12:30		Just Energy Transition		
12:30 – 13:00		Economic Development		
13:00 – 14:00	**Lunch**			
14:00 – 15:00	Open discussion and any other inputs		Facilitated Discussion	Task Team
15:00	**Closeout**			

Figure 114: Workshop schedule

Common insights across the engagements

Across the five engagements, there were some common key points raised as summarised in the table below:

Table 17 Common points across the engagements

Themes	Common points
Just Energy Transition	• Insufficient skills and technical knowhow o facilitate the transition • Infrastructure development needs as most of infrastructure is held by Eskom • Community buy-in and addressing such concerns • Potential job losses in the fossil fuel sector • High cost of renewable energy technologies • Need for clear policy direction and frameworks
Economic Development	• Energy insecurity hindering economic growth • Loadshedding causing business disruptions and job losses • Unreliable energy supply discouraging local investment, the case of Limpopo not being competitive compared to other provinces • Need for a skilled workforce for the new economy
Energy Security	• Loadshedding and energy shortage • Aging and deteriorating energy infrastructure • Lack of investment in renewable energy sources • Rising Eskom energy costs • The need for collaboration between various stakeholders from national, provincial, community, private and public sector

Unique insights from the various districts

There were specific concern and issues raised from each of the districts.

Vhembe Workshop: Energy Shortages and Service Delivery

- Problem: Loadshedding and energy shortages severely impacted service delivery in the Vhembe region. Critical infrastructure like water pumping stations were disrupted, leading to water scarcity and sanitation issues.
- Opportunity: The workshop explored the potential of renewable energy sources like solar or hydro to provide a more reliable and localized energy supply for critical services. This could ensure consistent water pumping and improve sanitation.

Waterberg Workshop: Stakeholder Engagement and Biogas Potential

- Focus: The Waterberg workshop emphasized the importance of actively engaging all stakeholders during the just energy transition. This includes communities, businesses, government entities, and NGOs. Collaboration is crucial for a smooth and equitable transition.
- Highlight: This workshop also identified a unique opportunity for the Waterberg region - generating biogas. Biogas is a renewable fuel produced from the decomposition of organic waste like agricultural residues. It can be used for cooking, heating, or even electricity generation, offering a potential source of clean energy and waste management.

Sekhukhune Workshop: Energy Insecurity and Crime

- Connection: This workshop delved deeper into the link between energy insecurity (unreliable power supply) and rising crime rates in the Sekhukhune district. Lack of lighting and limited security systems due to power outages were seen as contributing factors.
- Solution: The discussions focused on the need for sustainable and accessible energy solutions, particularly in vulnerable communities. This could involve expanding access to solar lighting or implementing alternative security measures that don't rely solely on electricity.

Capricorn Workshop: Monopoly Shift and Mutual Benefits

- Concern: Participants in the Capricorn workshop raised concerns about a potential shift in monopoly power. They feared that as Eskom's role declines, large industries might take over energy generation, creating a new kind of monopoly.
- Recommendation: The workshop emphasized the need to clearly communicate the benefits of a just energy transition for all stakeholders. This encourages a collaborative approach where communities and businesses can participate in the new energy landscape, avoiding a new form of monopoly control.

Vhembe District

Stakeholder engagements took place on the 27th of March 2024 at the University of Venda. This engagement had three groups each focusing on the same questions. For the sake of this report, the feedback from all groups has been consolidated into the three themes: energy security, economic development and just energy transition.

Overall, despite focusing on Just Transition, Economic Development and Energy Security, all groups agreed that unreliable energy hinders economic growth. Collaboration and skills development are seen as vital indicating that incorporating renewable energy into the Further Education and Training college (FET) colleges should be considered. While Group 1 worried about job losses in the coal sector, Group 3 highlighted the high cost of alternative energy sources as a concern.

Energy Security

Current Problems:

- High energy demand and infrastructure strain: Growing energy demand puts pressure on the existing infrastructure, leading to strain and potential for outages.
- Loadshedding and energy backlog: Frequent power cuts (loadshedding) disrupt essential services and economic activity. The district faces an energy backlog, meaning there's not enough electricity to meet demand.
- Affordability concerns and limited renewables integration: The high cost of electricity creates a burden for households and businesses. The current energy mix does not fully integrate alternative energy sources.

Root Causes:

- Poor planning and infrastructure neglect: Inadequate long-term planning for energy needs and a lack of investment in infrastructure maintenance contribute to vulnerabilities.
- Overreliance on traditional energy and population growth: Dependence on a single fuel source and a growing population make it difficult to meet energy demands.
- Theft and vandalism of infrastructure: Theft of cables and vandalism of infrastructure disrupt energy supply and increase costs.

Role of Renewables:

- Increased sustainable energy supply and reduced emissions: Renewables can provide a more reliable and sustainable energy supply, reducing dependence on fossil fuels and greenhouse gas emissions.
- Improved affordability and energy mix diversification: Renewable energy sources can offer cost-competitive options in the long term, diversifying the energy mix and potentially reducing overall energy costs.

Bottlenecks:

- Funding constraints and lack of collaboration: Securing funding for renewable energy projects and fostering collaboration between different stakeholders (government, private sector, communities) can be challenging.
- Limited awareness and policy inconsistency: A lack of public awareness about energy security issues and inconsistent government policies regarding renewables can hinder progress.

Working Together:

- Collaborative planning and policy development: Developing a comprehensive energy security plan through collaboration between stakeholders and establishing clear and consistent policies are essential.
- Land use management and public awareness campaigns: Effective land use management for renewable energy projects and raising public awareness about energy security are crucial.
- Law enforcement and infrastructure investment: Strengthening law enforcement to address theft and vandalism, and investing in upgrading and expanding energy infrastructure are necessary.

Capacity Needs:

- Project management and planning expertise: Developing expertise in project management and long-term energy planning is crucial for successful implementation of solutions.
- Technical training and community facilitation: Providing technical training in renewable energy technologies and facilitating community involvement in energy security initiatives are essential.

Economic Development

Current Problems:

- **Loadshedding disruptions and investment disincentive:** Frequent power outages disrupt businesses, reduce productivity, and discourage investment in the district.
- **High cost of doing business and infrastructure deficiencies:** The high cost of energy and unreliable electricity supply make the district less competitive. Poor infrastructure maintenance further strains the economy.
- **Limited skills and lack of advanced technology:** A shortage of skilled workers in renewable energy and limited access to advanced technologies hinder economic growth in the clean energy sector.

Root Causes:

- **Overreliance on traditional energy sources:** Dependence on a single fuel source (coal) makes the district vulnerable to supply disruptions and price fluctuations.
- **Inefficient energy production and distribution:** Inefficiencies in the current energy system led to higher costs and wasted resources.
- **Economic instability and lack of planning:** A lack of economic diversification and inadequate long-term planning constrain economic development.

Role of Renewables:

- **Economic simulation and job creation:** Renewable energy projects can create new jobs in construction, operation, and maintenance, stimulating economic activity.
- **Clean energy attracts investment and businesses**: Transitioning to a clean energy mix can attract environmentally conscious businesses and investments, boosting the economy.
- **Improved energy security and reduced business costs:** A reliable and sustainable energy supply from renewables can improve business continuity and reduce energy costs.

Bottlenecks:

- **Funding availability**: Securing financing for renewable energy projects can be challenging, especially for initial large-scale investments.
- **Political Will:** A lack of strong political commitment to the transition from traditional energy sources to renewables can create uncertainty for investors and slow down progress.
- **Technical skills gap**: The district faces a shortage of skilled workers in areas like renewable energy technology installation, maintenance, and project management.
- **Collaboration challenges:** Fragmented efforts by different stakeholders (government, private sector, training institutions) can hinder the development of a coordinated skills development program.
- **Limited access to information:** Businesses, particularly small and medium enterprises (SMEs), may lack access to information on renewable energy technologies and their potential economic benefits.
- **Business support:** A lack of access to financial and technical support can make it difficult for businesses to adopt or invest in renewable energy solutions.
- **Policy inconsistency:** Inconsistent or unclear government policies regarding renewable energy can create uncertainty for businesses and discourage investment.
- **Regulatory hurdles:** Complex or lengthy regulatory processes for renewable energy projects can add time and cost to development.

Just Energy Transition

Current Problems:

- **Skills mismatch and policy hurdles:** A lack of skills needed for renewable energy jobs and policy conflicts between different energy sources (coal vs. renewables) hinder a smooth transition.
- **Revenue loss and job displacement concerns:** Municipalities fear revenue losses from reduced reliance on coal, while residents worry about job losses in the coal sector.
- **Technology gap and high energy costs:** Limited access to advanced renewable energy technologies and high upfront costs pose challenges.

Root Causes:

- **Incompatibility and planning shortcomings:** Existing infrastructure may not be compatible with new renewable energy sources, and a lack of long-term planning creates uncertainty.
- **Storage constraints and skills gap:** The absence of large-scale energy storage solutions for renewables and a shortage of skilled workers in the clean energy sector create hurdles.
- **Social concerns and limited inclusion:** Job losses in the coal sector and a lack of community involvement in planning can lead to resistance to change.

Role of Renewables:

- **Clean energy investments and job creation:** Investing in renewable energy technologies can create new employment opportunities in areas like solar, wind, and bioenergy.
- **Sustainable environment and reduced emissions:** Transitioning to renewables can help mitigate climate change and create a more sustainable future for the district.
- **Skills development and economic diversification:** By focusing on renewable energy, the district can develop new skills and attract investments, diversifying the economy.

Bottlenecks:

- **Funding constraints and land availability**: Securing funding for renewable energy projects and obtaining access to suitable land can be challenging.
- **Collaboration gaps and policy inconsistency:** Fragmented efforts by different stakeholders and unclear or conflicting government policies create roadblocks.
- **Public awareness and resistance to change:** Limited public understanding of the benefits of renewables and potential resistance from those who rely on the coal sector can hinder progress.

Working Together:

- **Strengthen synergies and public engagement:** Fostering collaboration among stakeholders, raising public awareness, and promoting citizen participation are crucial.
- **Clear policy direction and governance structures:** Establishing clear and consistent government policies and strengthening governance structures are essential.
- **Alternative funding mechanisms and skills development:** Exploring alternative funding sources and investing in skills development programs can address financial and workforce challenges.

Capacity Needs:

- **Infrastructure development and technology transfer:** Upgrading infrastructure to accommodate renewables and facilitating technology transfer to bridge the technological gap are necessary.

- **Financial backing and project management expertise:** Securing financing for projects and developing project management expertise are crucial for successful implementation.
- **Facilitation and skills development:** Facilitating community engagement and developing a skilled workforce in renewable energy technologies are essential.

Waterberg District

Stakeholder engagements took place on the 29th of March 2024 at the Mogalakwena Municipality, OR Tambo Hall. This engagement had one group.

The Waterberg workshop highlighted unreliable energy as a major hurdle to economic growth, affecting aspects like tourism and agriculture. Renewable energy was seen as a solution to diversify the energy mix, reduce reliance on fossil fuels, and create new revenue streams. Stakeholder engagement and skills development were seen as crucial for a smooth transition.

Energy Security

Challenges:

- **Multiple energy sources:** Managing and integrating various renewable energy sources into the grid.
- **Biomass sustainability:** Ensuring a sufficient and sustainable supply of biomass for energy production.
- **Storage and distribution infrastructure:** Developing adequate storage and distribution networks for renewable energy.

Root Cause:

- Insufficient energy sources currently.

Solutions:

- **Renewable energy for a secure energy future:**
    - Contributes to social cohesion and a shared vision for energy security.
    - Promotes sustainable development through clean energy sources.
    - Enables the use of multiple energy technologies for a robust energy mix.

Economic Development

Challenges:

- **Energy disruptions:** Frequent power outages (load shedding) disrupt businesses, reduce agricultural productivity, and limit tourist attractions.
- **Infrastructure damage:** Vandalism of energy infrastructure necessitates repairs, adding financial strain.
- **Job losses:** Unreliable energy can lead to business closures and job losses.
- **Water supply:** Load shedding disrupts water pumping for irrigation, impacting agricultural production.

Root Causes:

- **Unreliable energy supply**: The current energy grid is insufficient to meet demand.
- **Energy imbalance:** Demand for energy outpaces supply.
- **Overreliance on fossil fuels:** Dependence on a single energy source creates vulnerabilities.

Solutions:

- **Renewable energy adoption:**
    - Reduces reliance on Eskom (the national power utility).
    - Combats climate change through reduced emissions.

- Attracts investment due to a more sustainable image.
- Creates revenue through construction of new renewable energy plants.
- Improves energy security by offering alternative sources like solar lighting.
- Diversifies the energy mix with solar panels and other renewables.
- Attracts new skilled workers in the renewable energy sector.

Just Energy Transition

Challenges:

- **Exploration and adoption of new technologies:** Identifying and implementing suitable renewable energy technologies like biogas from agricultural waste in the Waterberg district.
- **Energy storage readiness:** Assessing the agricultural sector's preparedness for energy capture and storage solutions.
- **Skills gap:** A lack of workforce skills necessary for renewable energy technologies.
- Fragmented information: Difficulty in accessing clear and consolidated information on renewable energy options.

Root Cause:

- Limited access to clear information on renewable energy technologies.

Solutions:

- **Renewable energy as a driver for just transition:**
  - Promotes social cohesion and fosters a shared vision for the future.
  - Enables sustainable development through clean energy practices.
  - Encourages the use of multiple energy technologies for a balanced approach.

Sekhukhune District

Stakeholder engagements took place on the 4th of March 2024 at the District Council Chamber in Groblersdal. This engagement had three groups.

Sekhukhune struggles with unreliable and expensive electricity, hurting businesses and jobs. A switch to renewables is seen as a solution but could cause job losses in fossil fuels. The workshop highlighted the need for collaboration, skills development, and clear policies to make this transition work. Funding, unclear policies, and infrastructure limitations are hurdles to overcome for renewable energy to become a reality.

Energy Security

Current Problems:

- **Over-reliance on Eskom:** The district's dependence on a single supplier makes it vulnerable to disruptions and outages experienced elsewhere on the national grid.
- **Limited public awareness:** Lack of knowledge about the benefits and feasibility of renewable energy technologies hinders their adoption by households and businesses.
- **Restrictive grid integration regulations:** Complex approval processes and bureaucratic hurdles can discourage investment in and development of renewable energy projects.

Root Causes:

- **Lack of diversification:** Over-reliance on Eskom limits the district's ability to control its own energy security and reduces resilience to grid instability.

- **Poor public education:** Limited public understanding of renewable energy options hinders their adoption as alternatives to traditional energy sources.
- **Bureaucratic hurdles:** Complex regulations create delays and discourage potential investors in renewable energy projects.

Solutions:

- **Pilot projects:** Showcase the success of renewable energy projects at a local level to build public confidence and encourage wider adoption.
- **Public awareness campaigns:** Educate residents about the benefits of renewable energy technologies, such as solar water heaters or rooftop solar panels.
- **Streamline grid integration:** Advocate for changes in regulations to simplify the process for connecting renewable energy projects to the grid.
- **Microgrid development:** Explore the development of localized power grids powered by renewable energy sources to provide energy security for remote communities not connected to the national grid.
- **Grid modernization:** Invest in upgrading the existing energy grid to improve efficiency and accommodate the integration of renewable energy sources.

Bottlenecks:

- **Funding:** Securing funding for renewable energy projects and grid modernization initiatives.
- **Technical expertise:** Building the technical capacity for developing and managing renewable energy projects and grid integration.
- **Political will:** Ensuring political commitment to implementing reforms that incentivize renewable energy development and streamline grid integration processes.
- **Working together:** Collaboration between government, energy providers, and communities is essential for creating a secure and sustainable energy future for the Sekhukhune district.

Capacity Needed:

- **Engineering expertise:** Building capacity for developing and managing renewable energy projects and grid integration processes.
- **Resources for grid upgrades:** Securing funding and technical expertise for upgrading and modernizing the existing energy grid infrastructure.
- **Effective communication:** Developing strong communication skills to raise public awareness about renewable energy and build public support for energy security initiatives.
-

Economic Development

Current Problems:

- **Unreliable energy:** Frequent power outages disrupt business operations, leading to production slowdowns, project delays, and lost revenue. The uncertainty discourages investment.
- **High energy costs:** High electricity costs strain business budgets, reduce profit margins, and hinder reinvestment in businesses.
- **Policy misalignment:** Current policies may not adequately incentivize or support the development of a renewable energy sector, limiting economic opportunities.

Root Causes:

- **Over-reliance on Eskom:** Dependence on a single, centralized energy supplier makes the district vulnerable to grid instability and national supply disruptions.
- **Limited renewables:** Lack of investment in and adoption of renewable energy sources restricts opportunities for clean energy businesses.

- **Inadequate Skills:** The current workforce may not possess the skills necessary to participate in the development and maintenance of renewable energy projects.

Solutions:

- **Prioritize renewables:** Invest in developing a mix of renewable energy sources like solar, wind, and biomass to provide a reliable and sustainable energy supply for businesses.
- **Land allocation:** Streamline processes for allocating land for renewable energy projects while considering the needs and interests of local communities.
- **Upskilling for new economy:** Implement training programs to equip the local workforce with the skills needed for jobs in the clean energy sector.
- **Policy advocacy:** Advocate for policy changes that incentivize investment in renewable energy (e.g., tax breaks, feed-in tariffs) and streamline regulations for renewable energy projects.

Bottlenecks:

- **Funding:** Securing financing for renewable energy projects can be challenging, especially for small and medium-sized enterprises.
- **Land availability:** Identifying suitable land for renewable energy projects while addressing potential land use conflicts.
- **Traditional leadership:** Ensuring buy-in and collaboration from traditional leadership structures for renewable energy projects on communal land.
- **Working together:** Collaboration between government, private sector, and communities is critical for fostering economic development through a just energy transition. Government can provide policy frameworks and incentives, the private sector can invest in renewable energy projects and create new jobs, and communities can contribute local knowledge and participate in project ownership models.

Capacity Needed:

- **Technical expertise:** Building capacity for developing, installing, and maintaining renewable energy projects.
- **Investment capital:** Securing funding for renewable energy projects through a combination of public and private investment sources.
- **Business development skills:** Strengthening the capacity of local businesses to participate in the clean energy sector.

Just Energy Transition

Current Problems:

- **Electricity:** Loadshedding disrupts daily routines and strains household budgets. High electricity costs disproportionately impact low-income residents.
- **Job losses:** A rapid shift to renewables could displace workers in coal mining, power generation, and related industries, leading to social unrest and economic hardship.

Root Causes:

- **Lack of investment**: Inadequate investment in renewable energy sources hinders progress towards a clean energy future.
- **Planning shortfalls:** The absence of a comprehensive just transition plan creates uncertainty for workers and communities about the future.
- **Fossil fuel dependence:** Overreliance on fossil fuels limits the development and adoption of renewable energy alternatives.

Solutions:

- **Just transition plan**: Develop a roadmap for the transition that outlines strategies for reskilling and upskilling the workforce, providing social support programs for displaced workers, and ensuring community buy-in for renewable energy projects.
- **Reskilling and upskilling programs:** Equip workers with the skills needed for jobs in the clean energy sector, such as solar panel installation, wind turbine maintenance, and biofuel production.
- **Social support programs:** Provide financial assistance and job placement services to ease the transition for workers who lose their jobs due to the shift to renewables.
- **Community engagement**: Collaborate with traditional leaders and community organizations to develop models for community ownership and participation in renewable energy projects.

Bottlenecks:

- **Funding:** Securing funding for just transition programs, reskilling initiatives, and social support services.
- **Vested interests:** Overcoming resistance from stakeholders who benefit from the current fossil fuel-based energy system.
- **Community buy-in:** Addressing concerns and ensuring communities understand the benefits of renewable energy projects.
- **Working together:** Collaboration between government, private sector, traditional leaders, and communities is essential for a successful just energy transition. Each group brings unique resources, perspectives, and expertise to the table.

Capacity Needed:

- **Skill development:** Building capacity for delivering training programs and developing the skills needed for clean energy jobs.
- **Financial resources**: Securing funding to support the just transition plan and its various components.
- **Leadership and coordination:** Strong leadership and effective coordination mechanisms are crucial for overseeing the just transition process.

Capricorn District

Stakeholder engagements took place on the 6th of March 2024 at the Polokwane Landmark Hotel. This engagement had two groups.

The Capricorn workshop highlighted similar challenges to the other districts with unreliable electricity hindering economic development. A key theme was the fear of the unknown surrounding renewable energy. Participants emphasized the need for awareness campaigns and education to address these concerns. Collaboration among stakeholders, including traditional leaders and communities, was seen as crucial.

Energy Security

Current Problems:

- **Lack of skills**: The district lacks a workforce with the skills necessary to design, install, maintain, and operate renewable energy infrastructure.
- **Infrastructure development:** Insufficient infrastructure (e.g., transmission lines) is needed to connect renewable energy sources to the grid and distribute power effectively.
- **Community issues:** Gaining buy-in from traditional leaders and addressing concerns from community groups is crucial for project acceptance and social cohesion.
- **Monopoly shift concerns:** A shift from Eskom's monopoly to dominance by large industries due to their ability to afford renewable energy could create new challenges.

- **Resistance from Eskom:** Overcoming potential resistance from Eskom, which may see renewable energy as a threat to its traditional role, is essential.
- **Political considerations:** Obtaining political buy-in from municipalities that rely on energy revenue is necessary for a successful transition.
- **Non-payment by municipalities:** Unpaid bills by municipalities to energy providers create financial instability and hinder investment in new energy solutions.
- **Land availability:** Finding suitable land for renewable energy projects at a reasonable cost can be a challenge.

Root Causes:

- **Fear of the unknown:** Uncertainty about the impacts of a just transition can lead to resistance from communities and stakeholders.
- **Lack of knowledge and communication:** Inadequate communication and education about renewable energy benefits can hinder public support.
- **Reliance on traditional energy sources:** Overdependence on existing energy sources creates inertia and resistance to change.

Solutions:

- **Project continuity:** Ensuring minimal disruptions to projects due to community concerns fosters confidence and progress.
- **Community benefits:** Renewable energy projects should improve the overall living environment and offer tangible benefits to communities.
- **Economic boost:** A just transition can enhance economic competitiveness, attract investment, and create jobs.
- **Stable energy supply:** Renewable energy can provide a more reliable and predictable energy source, reducing load shedding.
- **Reduced crime:** Improved lighting and security measures associated with renewable energy projects can potentially decrease crime rates.
- **Sustainable services:** Reliable energy supply is essential for uninterrupted provision of essential services like water and sanitation.
- **Reduced carbon footprint:** Transitioning to renewables reduces greenhouse gas emissions and improves the district's environmental profile.
- **Improved IGR**: Effective collaboration among stakeholders can maximize the benefits of renewable energy projects and improve revenue generation.

Bottlenecks:

- **Cost-benefit analysis:** Providing a compelling case that highlights the individual and collective benefits of renewable energy can overcome resistance.
- **Raising awareness:** Community education programs can raise awareness about the potential of renewable energy and address concerns.

Working Together:

- **Mutual benefits:** Highlighting the shared benefits of a just transition for communities, businesses, and the environment can foster collaboration.
- **Reskilling programs:** Investing in programs to equip the workforce with the necessary skills for a renewable energy future is crucial.

Capacity Needs:

- **Financial support:** Funding is needed for infrastructure development, skills training, and project implementation.
- **New curriculum:** Developing educational programs focused on renewable energy can build a skilled workforce for the future.

Economic Development

Current Problems:

- **Unemployment:** Energy insecurity disrupts businesses, leading to job losses and economic stagnation.
- **Poverty:** Load shedding and unreliable energy hinder economic activity, trapping residents in poverty.
- **Reduced investment:** Unreliable energy discourages businesses from investing in the district.
- **Poor economic growth:** The energy crisis creates a drag on economic development.

Root Causes:

- **Energy crisis:** Load shedding disrupts production and creates uncertainty for businesses.
- **Competitive disadvantage:** Unreliable energy hinders the district's ability to attract investment compared to areas with stable power.
- **Inter-competition:** Competition for limited energy resources can create conflict and hinder development.

Solutions:

- **Economic growth:** Renewable energy can provide a reliable power source, stimulating economic activity and growth.
- **Poverty reduction:** Economic growth fuelled by reliable energy can create jobs and lift people out of poverty.
- **Investment attraction:** A stable energy supply can make the district more attractive to investors.
- **Job creation:** The transition to renewable energy can create new jobs in installation, maintenance, and manufacturing.

Bottlenecks:

- **Public participation:** Engaging communities in the planning process can foster ownership and a sense of responsibility for the transition.
- **Resistance:** Fear of the unknown can lead to resistance from businesses and individuals.
- **Business sabotage:** Competition or fear of change might lead to attempts to undermine the strategy execution.

Just Energy Transition

Current Problems:

- **Lack of skills:** A workforce without the necessary skills to install, maintain, and operate renewable energy infrastructure hinders the transition.

- **Infrastructure development:** The district may lack the infrastructure needed to effectively utilize renewable energy sources (e.g., transmission lines for solar farms).
- **Community issues:** Gaining buy-in from traditional leaders and addressing concerns of residents regarding potential impacts is crucial.
- **Monopoly shift concerns:** A shift from Eskom's dominance to private industries controlling renewable energy could raise concerns about affordability and access.
- **Resistance from stakeholders:** Eskom and municipalities may resist the transition due to potential loss of revenue or control.
- **Political considerations:** Municipal focus on revenue collection from energy sales could conflict with long-term sustainability goals of renewable energy.
- **Payment issues:** Outstanding debts owed to Eskom and private energy providers create financial strain and hinder investment in new solutions.
- Land availability: Finding suitable land for renewable energy projects at a reasonable cost can be challenging.

Root Causes:

- **Fear of the unknown:** People may be apprehensive about the potential impacts of a just transition on their livelihoods or communities.
- **Lack of knowledge and communication:** Inadequate information and communication about the benefits and processes of the transition can breed mistrust and resistance.
- **Reliance on traditional energy sources:** Overdependence on existing energy sources creates a barrier to embracing renewable alternatives.

Solutions:

- **Reduced project stoppages:** Open communication and addressing community concerns can minimize project delays due to protests.
- **Improved environment:** Renewable energy can lead to cleaner air, improved aesthetics, and a more sustainable district.
- **Economic benefits:** The transition can create new jobs, boost competitiveness, and attract investment.
- **Stable energy supply:** Renewable energy can reduce reliance on Eskom and provide a more reliable power source.
- **Crime reduction:** Improved lighting due to renewable energy can potentially deter crime.
- Sustainable services: Reliable energy ensures consistent delivery of basic services like water pumping.
- **Reduced carbon footprint:** Transitioning to renewables contributes to environmental protection and a positive global image.
- **Improved revenue collection:** A thriving economy due to renewable energy can lead to increased tax revenue for municipalities.

Bottlenecks:

- **Compelling case:** Effective communication needs to present a clear picture of both the individual costs and the broader societal benefits of the transition.
- **Awareness about renewables:** Educational campaigns can increase public understanding and support for renewable energy solutions.

Working Together:

- **Showcase mutual benefits:** Highlighting the advantages for both communities and stakeholders can foster collaboration.
- **Reskilling programs:** Investing in training programs can equip the workforce with the necessary skills for the renewable energy sector.

Capacity Needed:

- **Financial support:** Funding is needed for infrastructure development, skills training, and project implementation.
- **New curriculum:** Educational institutions need to adapt their curriculums to include renewable energy skills.

Mopani District

Stakeholder engagements took place on the 8th of March 2024 at the Tzaneen Disaster Management Centre. This engagement had two groups.

The Mopani workshop highlighted challenges like other districts regarding unreliable electricity and a need for a just transition to renewables. A key point raised was the lack of skilled workers to support this transition. One of the areas highlighted the opportunity of Technical and Vocational Education and Training (TVET) Colleges. By aligning their curriculum with the new trends of solar energy, TVETs can equip the workforce with the necessary skills to design, install, and maintain renewable energy systems. This would address the skills gap and create new job opportunities in the renewable energy sector, facilitating a smoother just transition.

Energy Security

Current Problems:

- **Technical skills gaps:** A shortage of skilled personnel hinders the effective maintenance and operation of existing energy infrastructure and limits the ability to develop and manage renewable energy projects.
- **Infrastructure vulnerability:** Vandalism of infrastructure (theft of solar panels and cables) and illegal connections pose a threat to energy security and disrupt electricity supply.
- **Lack of public awareness:** Limited understanding of energy security issues and the benefits of renewable energy can hinder public support for security measures and community-based solutions.

Root Causes:

- **Inadequate investment in infrastructure**: Underinvestment in infrastructure maintenance and security measures leaves the grid vulnerable to vandalism and theft.
- **Limited community engagement:** Lack of communication and collaboration with communities on energy security issues can create a sense of disenfranchisement and hinder efforts to address theft and vandalism.
- **Unaffordability of legal energy access**: High electricity costs can incentivize some residents to resort to illegal connections, jeopardizing grid stability and energy security.

Role of Renewables:

- **Increased energy supply:** Renewable energy sources can diversify the energy mix and reduce dependence on a single, vulnerable supplier, enhancing energy security.
- **Community ownership models:** Community ownership of renewable energy projects can foster a sense of responsibility and encourage residents to protect infrastructure from vandalism.
- **Reduced reliance on fossil fuels:** Transitioning to renewables can lessen reliance on imported fossil fuels, improving energy security and reducing vulnerability to price fluctuations.

Bottlenecks:

- **Funding constraints:** Securing funding for infrastructure upgrades, security measures, and community-based renewable energy projects can be challenging.
- **Lack of collaboration:** Fragmented efforts by different stakeholders in addressing energy security issues can hinder progress.

- **Limited enforcement mechanisms**: Weak enforcement of laws and regulations against illegal connections can undermine efforts to improve grid stability and energy security.

Working Together:

- **Multi-stakeholder collaboration:** Collaboration between government, energy providers, security agencies, and communities is crucial for developing and implementing effective energy security strategies.
- **Community engagement and awareness campaigns:** Raising awareness about energy security issues, educating communities about the benefits of renewables, and fostering a sense of shared responsibility are essential.
- **Investment in infrastructure security:** Upgrading infrastructure, implementing security measures, and investing in renewable energy projects in collaboration with communities can enhance energy security.

Capacity Needs:

- **Resource mobilization:** Developing strategies to attract funding for infrastructure upgrades, security measures, and community-based renewable energy projects.
- **Data sharing and analysis:** Establishing mechanisms for sharing data on energy security issues to inform collaborative decision-making.
- **Law enforcement capacity building:** Strengthening the capacity of law enforcement agencies to effectively address illegal connections and vandalism of energy infrastructure.

Economic Development

Current Problems:

- **Loadshedding:** Frequent power outages disrupt businesses, leading to production slowdowns, lost revenue, and job losses. This hinders economic growth and development in the district.
- **Aging infrastructure:** The district's aging energy infrastructure is unreliable and inefficient, further contributing to energy insecurity and economic disruptions.
- **Siloed planning:** Lack of coordinated planning between different government departments and stakeholders can create inefficiencies and hinder progress towards a sustainable energy future.

Root Causes:

- **Over-reliance on Eskom:** The district's dependence on a single, centralized energy supplier makes it vulnerable to grid instability and national supply disruptions.
- **Illegal connections:** Prevalence of illegal electricity connections increases the strain on the grid and reduces revenue for legitimate energy providers.
- **Limited investment in renewables:** Inadequate investment in renewable energy sources hinders the development of a more reliable and sustainable energy supply for businesses and residents.

Role of Renewables:

- **Reduced dependence on Eskom:** Diversifying the energy mix through renewables can lessen reliance on Eskom and reduce vulnerability to national grid issues.
- **Lower energy costs:** Renewable energy sources, particularly solar and wind power, have the potential to provide a more cost-effective energy supply in the long run, benefiting businesses and households.

- **New business opportunities:** Investing in renewable energy infrastructure and technologies can create new business opportunities in areas like installation, maintenance, and manufacturing.

Bottlenecks:

- **Political will**: A lack of political commitment to prioritize renewable energy development and implement necessary policy reforms can hinder progress.
- **Siloed planning approaches:** Fragmented planning and decision-making across different government departments and stakeholders can create inefficiencies and delays.
- **Financing challenges:** Securing funding for renewable energy projects can be challenging, especially for smaller municipalities and private sector developers.
- **Access to technology and expertise:** Limited access to cutting-edge renewable energy technologies and a shortage of skilled professionals in the field can hinder project development.

Working Together:

- **Integrated planning:** Developing a comprehensive and coordinated plan that involves all stakeholders (government, private sector, communities) is essential for maximizing economic benefits from the energy transition.
- **Public-private partnerships:** Fostering partnerships between public and private entities can leverage resources, expertise, and risk-sharing for renewable energy projects.
- **Capacity building:** Investing in training programs and skills development initiatives can equip the local workforce with the skills needed to participate in the clean energy economy.

Capacity Needs:

- **Financial planning and investment mechanisms:** Developing innovative financing models (e.g., public-private partnerships, green bonds) to attract investment in renewable energy projects.
- **Technology transfer and innovation:** Collaboration with research institutions and technology providers to ensure access to cutting-edge renewable energy technologies.
- **Data collection and analysis:** Strengthening data collection and analysis capabilities to inform decision-making on energy planning and investment in renewables.

Just Energy Transition

Current Problems:

- **Limited planning and resources:** Lack of research, inadequate budget, and a shortage of skilled workers hinder the development of a comprehensive just transition plan.
- **Unconducive policy environment:** Existing policies and regulations may not adequately support a just transition, creating uncertainty for workers and communities.
- **Land ownership issues:** Reliance on Permission to Occupy (PTO) systems instead of title deeds discourages investment in renewable energy projects on communal land. Potentially inflated land prices can further complicate land acquisition.

Role of Renewables:

- **Job creation and economic opportunities:** Renewable energy development can create new jobs in installation, maintenance, and manufacturing, fostering economic diversification.
- **Reliable energy supply:** Renewables can provide a more stable and predictable energy source, reducing disruptions caused by loadshedding. This can benefit businesses and improve living standards.
- **Community ownership models:** Community ownership of renewable energy projects can create economic opportunities and provide a sense of agency for local residents.

Bottlenecks:

- **Policy reform**: Complexities and potential inconsistencies in energy policies create uncertainties for investors and developers of renewable energy projects. Streamlining regulations and providing clear incentives is crucial.
- **Skill gaps**: The current workforce may not possess the skills needed for jobs in the renewable energy sector. Investment in training programs is essential to bridge this gap.
- **Limited public awareness:** Lack of understanding about the benefits and feasibility of renewable energy technologies can hinder public support and community buy-in for projects.

Working Together:

- **Government leadership:** Government needs to play a proactive role by developing a clear just transition plan, facilitating policy reforms, and providing financial support for training and infrastructure development.
- **Private sector investment:** Collaboration with private companies is crucial for attracting investment in renewable energy projects and creating new job opportunities.
- **Community engagement:** Meaningful engagement with communities throughout the planning and implementation process is essential to address concerns, ensure transparency, and build trust.

Capacity Needs:

- **Research and development:** Investment in research and development is needed to explore new renewable energy technologies and adapt them to local contexts.
- **Training and skills development:** Developing training programs to equip the workforce with the skills needed for the clean energy sector is crucial for a successful just transition.
- **Effective communication:** Building strong communication channels to raise public awareness about renewable energy and address community concerns is essential.

The workshops for the development of a renewable energy strategy for Limpopo in various districts has yielded crucial insights and provided clarity about challenges they currently facing, all the districts have faces significant hurdles such as load shedding, causing adverse effects on employment, education, and the health sector, as well as disruptions in agriculture. The operational disturbance in farming, high costs of alternative energy sources, and limited funding further exacerbate the challenges. Additionally, issues like poor maintenance, geopolitical tension, and a lack of technical skills hinder progress. With common discussion points being identified as per Figure 112.

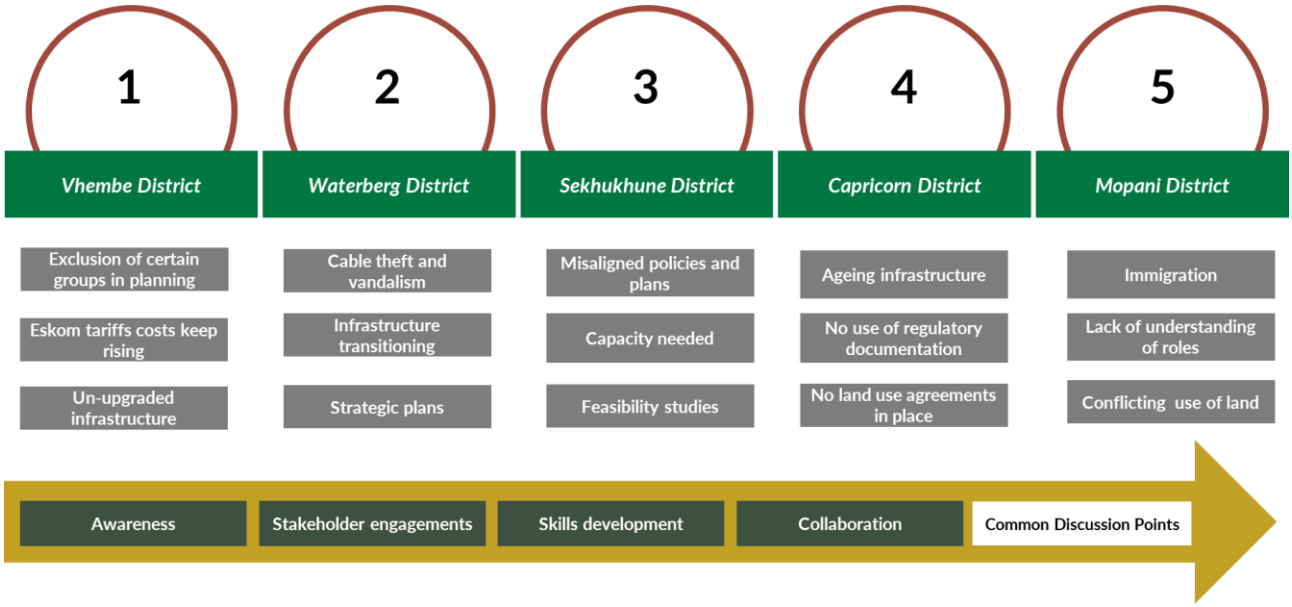


Figure 112: Stakeholder key inputs

Overall, the key takeaways include the urgent need for clear policy direction, financial backing, infrastructure development, and skills enhancement in all districts. The proposed solutions underscore the importance of collaboration, innovation, and aligning strategies with broader economic and technological trends. Addressing challenges such as load shedding, theft, and skills gaps requires a comprehensive and coordinated effort involving various stakeholders at local and regional levels.

ANNEXURE B: ACTIVITY PLANS AND INTIATIVES

Energy Security

Strategic Outcome	Intervention	Baseline State	Target State	Cost	Potential Stakeholders	Target Audience	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7	Activity 8
Energy Security	**Storage**	Baseline no storage, limited storaged capacity its support generation capacity and load requirements	600MW of BESS by 2030 with 100MW installation per annum starting from 2025	Approximately between R8.9Billion and R13.7Billion annually for 100MW installations - Aproximate total of R53.4Billion and R82.2Billion	1. OEMs (Original Equipment Manufacturer) 2. Project developers 3. Energy modelling 4. Transaction advisers 5. Private enterprises 6. CoGHSTA	1. Municipalities	**Pre-feasibility Study - Energy Modeling:** 1. Energy modelling at a Municipal level to establish localized demand and generation to understand BESS contribution (targets for batteries within their jurisdiction). **Output:** Report on local energy modeling and BESS targets	**Update Municipal Energy Management Plans:** 1. Municipalities update their energy management plans as part of their IDP processes. **Output:** Updated energy management plans within municipal IDPs	**Approach Funding Partners:** 1. DFIs to assist with project preparartion, funding from (DBSA, IPPs) and support. **Output:** Secured commitments for project preparation funding and support	**Bankable Feasibility Study:** 1. Conduct transaction advisory processes to develop the appropritae commercial structure. **Output:** Bankable feasibility study ready for investor review	**Develop Commercial Structure:** 1. Conduct transaction advisory processes to develop the appropritae commercial structure. 2. Evaluate and select the best financing options based on risk, cost, and benefit analysis. **Output:** Established commercial structure and identified financing strategy	**Capital Raising and Contracting:** 1. Obtain the necessary capital and finalize contracts for project execution. **Output:** Financial closure achieved	EPC: 1. Engineering, Procurement and Construction. **Output:** Commissioned BESS or storage capacity	**Continuous Operation**
Energy Security	**Grid Monitoring and Development**	As per GCCA 3360MW grid capacity upto 2025 factoring the 930MW of IPPs coming online then	**By 2030, integrate at least 2400 MW of new renewable generation capacity** into the provincial grid, with a comprehensive monitoring system established by 2028 to ensure continuous grid stability and efficiency, measured by achieving minimal grid downtime annually	Approximately between R178Million and R445Million of Total Project management and Other Costs (2-5% of CAPEX)	1. OEMs (Original Equipment Manufacturer) 2. Project developers 3. Energy modelling 4. Transaction advisers 5. Private enterprises 6. Grid Assessors 7. CoGHSTA	1. Municipalities	**Conduct Distribution Grid Capacity Assessment:** 1. Complete a detailed grid assessment report that identifies capacity limitations and outlines necessary upgrades for integrating increased load, storage, and renewable generation. **Output:** Detailed assessment report outlining current grid status, future needs, and recommended actions for capacity enhancement	**Update Municipal Energy Management Plans:** 1. Municipalities update their energy management plans as part of their IDP processes. **Output:** Updated energy management plans within municipal IDPs	**Approach Funding Partners:** 1. DFIs to assist with project preparartion, funding from (DBSA, IPPs) and support. **Output:** Secured commitments for project preparation funding and support	**Bankable Feasibility Study:** 1. Conduct transaction advisory processes to develop the appropritae commercial structure. **Output:** Bankable feasibility study ready for investor review	**Develop Commercial Structure:** 1. Conduct transaction advisory processes to develop the appropritae commercial structure. 2. Evaluate and select the best financing options based on risk, cost, and benefit analysis. **Output:** Established commercial structure and identified financing strategy	**Capital Raising and Contracting:** 1. Obtain the necessary capital and finalize contracts for project execution. **Output:** Financial closure achieved	EPC: 1. Engineering, Procurement and Construction. **Output:** Commissioned BESS or storage capacity	**Continuous Operation**
Energy Security	**Municipalities to Facilitate Wheeling**	**Limited wheeling due to:** 1. Most Municipalities cannot wheel due to indebtness to Eskom 2. Need to have a distirbution licence	**Unconstrainted wheeling environment by:** 1. End of 2030 Unlincenced Municipalities to be licenced 2. End of 2030 eliminate Eskom indebted Municipalities	Cost (OPEX and CAPEX) determined on a case by case basis based on individual Muncipality status in terms of licencing and debt	1. NERSA 2. Eskom 3. Provincial Treasury 4. Advisory services 5. CoGHSTA	1. Municipalities 2. IPPs 3. Large Scale Consumers (>1kV)	**Review Debt Obligations with Eskom:** 1. Assess and review current debt obligations with Eskom to understand financial liabilities. 2. Municipalities to debt review process or review debt obligations with Eskom. **Output:** Comprehensive debt review report detailing all current obligations and terms	**Develop Mitigating Interventions for Debt Obligations:** 1. Create interventions to manage and mitigate debt, ensuring municipalities can be licensed. 2. Where there are debt obligations, develop mitigating interventions in order for them to be licenced. **Output:** Implemented debt management strategies, documented in agreements or revised terms.	**Create a Wheeling Process Document:** 1. Municipality create a wheeling process document to facilitate stakeholder engagements. **Output:** Wheeling process document ready for stakeholder review and feedback	**Develop a Wheeling Policy:** 1. Formulate a wheeling policy to regulate and facilitate energy distribution between producers and the grid. 2. Draft the policy incorporating feedback from the wheeling process document. **Output:** Wheeling policy approved by the council	**Facilitate Wheeling Agreements:** 1. Formalize wheeling agreements to govern the distribution of energy between entities. 2. Utilize existing templates to draft agreements. **Output:** Established wheeling agreements ready for implementation	**Update billing system to implement the energy settlement calculations required for wheeling:** 1. Develop a billing system capable of managing transactions involved in energy trading or make use of estblished systems. 2. Design and test a software-based billing system that integrates with existing municipal infrastructure. 3. Train staff on the new system. **Output:** Operational billing system for energy wheeling	**Implement Wheeling Service:** 1. Utilize existing templates to draft agreements. 2. Customize agreements to specific municipal needs and legal requirements. **Output:** Established wheeling agreements ready for implementation.	**Continuous management of wheeling service offering**
Energy Security	**Municipalities to Facilitate Energy Storage and Distribution**	Low to limited trading by Municipalities due to: 1. Need to have a distirbution licence 2. Limited or nonexist capabilities to trade power	**Unconstrainted trading environment by:** 1. End of 2030 Unlincenced Municipalities to be licenced	Cost (OPEX and CAPEX) determined on a case by case basis based on individual Muncipality status in terms of licencing and debt	1. NERSA 2. Eskom 3. Provincial Treasury 4. Advisory services 5. IPPs 6. CoGHSTA	1. Municipalities 2. Embedded Generators	**Build a Municipal Trading Framework:** 1. Develop a framework that includes guidelines for NERSA tariff applications and adherence to the grid code. 2. Apply for and secure tariff approvals from NERSA. **Output:** Established municipal trading framework with NERSA tariff approval and grid code compliance	**Develop a Trading Policy:** 1. Draft a trading policy that outlines the roles, responsibilities, and procedures for energy trading within the municipality. 2. Present the policy to the municipal council for review and approval. **Output:** Trading policy approved by the municipal council	**Choose a Trading Tariff:** 1. Analyze various tariff models and their impacts on the energy market and municipal revenues. 2. Decide on the most suitable tariff structure to encourage trading while ensuring financial sustainability. **Output:** Officially selected "Storage Tariff" for municipal energy trading.	**Update billing system to implement the energy settlement calculations required for trading:** 1. Develop a billing system capable of managing transactions involved in energy trading or make use of estblished systems. 2. Design and test a software-based billing system that integrates with existing municipal infrastructure. 3. Train staff on the new system. **Output:** Operational billing system for energy trading	**Create Awareness for Embedded Generators:** 1. Inform and educate embedded generators about how they can participate in and benefit from the municipal storage and trading system. 2. Develop and distribute informational materials, including benefits and procedures for joining the trading system. 3. Hold informational sessions and workshops for potential and existing embedded generators. **Output:** Enhanced awareness and participation from embedded generators in the municipal energy trading system.	**Implement the Trading Market:** 1. Successfully launch and operationalize the municipal energy trading market. 2. Set up the necessary infrastructure and systems to support trading activities. 3. Monitor and refine trading operations based on initial performance and feedback. **Output:** Fully functional and active municipal energy trading market		**Continuous management of the trading system**

Table 16 Energy Security initiatives and Activity Plan

Economic Development

Strategic Outcome	Intervention	Baseline State	Target State	Cost	Potential Stakeholders	Target Audience	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7	Activity 8
Economic Development	**Alternative and Targeted Financing Mechanisms**	Electricity supply is financed through Municipality distribution margins and grant allocations such as Municipal Infrastructure Grants (MIGs)	By the end of 2025, introduce **new financing mechanisms**, thereby reducing dependency on grants and stabilizing Municipality funding sources for ongoing and new initiatives Municipalities leverage other financing mechanisms including, Credit solutions, Project finance etc. in line with Municipal borrowing framework from (Municipal Finance Management Act - MFMA)	OPEX cost the time and effort to discuss and generate the required financing agreements	1. Development Financial Institution (DFIs) 2. Commercial banks 3. Provincial Treasury 4. Transaction advisory 5. CoGHSTA	1. Municipalities	**Feasibility Study and Selection of Financing Mechanisms** 1. Conduct a feasibility study to assess various financing options including municipal bonds, public-private partnerships, green bonds, lease-revenue bonds, and crowdfunding platforms. 2. Analyze financial models, potential investor interest, and alignment with municipal needs and capacities. **Output:** Report on selected financing mechanisms with detailed analysis of viability and strategic fit **Timeline:** Completion by Q2 2025	**Develop Implementation Strategies:** 1. Create detailed action plans that include steps for legal approval, market analysis, investor outreach, and administrative setup. 2. Engage financial advisors and legal consultants to ensure compliance with regulations and to enhance financial structuring. **Output:** Tailored financing mechanisms ready for implementation **Timeline:** Strategies to be developed by Q3 2025	**Stakeholder Engagement and Partnerships:** 1. Organize workshops and information sessions with community leaders and the public to discuss benefits and implications of new financing mechanisms. 2. Hold meetings with potential investors and partners to establish roles and commitments. **Output:** Documented support and partnerships for financing initiatives **Timeline:** Ongoing engagement with key milestones by end of Q4 2025	**Implementation and Launch:** 1. Finalize all legal and regulatory approvals required to implement new financing mechanisms. 2. Start the implementation process including marketing the financing options to potential investors and integrating mechanisms into municipal financial systems. **Output:** New financing mechanisms operational and initial funds raised **Timeline:** Launch by the end of Q4 2025	**Monitoring and Evaluation:** 1. Establish metrics and KPIs to assess the performance of each financing mechanism in terms of capital raised and impact on municipal funding stability. 2. Implement a monitoring system to regularly collect data and evaluate performance. **Output:** Regular monitoring reports with insights and recommendations for adjustments **Timeline:** Start monitoring immediately after launch; first evaluation report due by Q1 2026			**Continuous monitoring and updated if need be of financing mechanisms**
Economic Development	**Job Creation Across the Value Chain**	Limpopo produces some of the minerals that feed into the supply chain, but there is limited manufacturing in the space and most job opportunities are in the installation and operation of renewable systems	Develop and create approximately: 1. 2728 Direct Construction Jobs 2. 1183 Operation and Maintenance FTE Jobs From total **Solar PV installations** of 2400MW by 2030 (CSIR Socio-economic benefits of renewable and storage technologies in South Africa study utilized) 1. 691 Direct Colostruction Jobs 2. 1596 Induced Jobs From **total BESS installations** of 600MW (CSIR Socio-economic benefits of renewable and storage technologies in South Africa study utilized)	Approximately between R178Million and R445Million for O&M of BESS and R240Million and R600Million for O&M of Biodigesters (2 - 5% of CAPEX)	1. LEDET and its agencies 2. Academic institutions 3. SEDA 4. Municipalities (economic development and infrastructure functions) 5. CoGHSTA 6. National Democractic Institute (NDI)	1. Limpopo population 2. Businesses in Limpopo 3. IPPs 4. Municipalities	**Industry Analysis and Job Mapping:** 1. Conduct a comprehensive analysis of the current state of the renewable energy industry, including major players, technological advancements, and market trends. 2. Map out the value chain, pinpointing where new jobs can be created at each stage: manufacturing, installation, operation, and maintenance. **Output:** Detailed report on potential job creation opportunities within the renewable energy value chain **Timeline:** Complete analysis and mapping within 6 months of 2025	**Skill Gap Analysis and Training Program Development with Univem and TVET Colleges:** 1. **Collaborative Analysis:** Work closely with Univen (University of Venda) and TVET colleges to analyze current workforce capabilities against future industry needs, identifying specific skill gaps. 2. **Curriculum Development:** Jointly develop training curricula that are tailored to the specific requirements of the renewable energy sector, focusing on areas such as solar panel installation, wind turbine maintenance, and energy systems management. 3. **Program Implementation:** Launch training programs across these institutions, ensuring they are accessible to a broad segment of the potential workforce, including new entrants and existing workers seeking skill enhancement. **Output:** Established training programs aligned with industry needs **Timeline:** Start analysis immediately and launch first training programs within 1 year	**Stakeholder Engagements and Partnership Formation:** 1. Identify potential industry partners, local governments, and community organizations that can support or benefit from job creation. 2. Organize stakeholder meetings to discuss collaboration opportunities and secure commitments. **Output:** Strategic partnerships that facilitate job creation and support for renewable energy projects **Timeline:** Ongoing engagement, with initial partnerships formed within 2025	**Implementation of Job Creation Initiatives:** 1. Launch initiatives that directly lead to job creation, such as new manufacturing facilities, installation projects, and service centers for maintenance. 2. Utilize partnerships and training programs to staff these initiatives with skilled workers. **Output:** New jobs created across the value chain and successful placement of trained personnel **Timeline:** Begin implementation within 18 months and continue as new opportunities arise	**Monitoring, Evaluation, and Scaling:** 1. Establish metrics to evaluate the success of job creation initiatives, including job retention rates and economic impact. 2. Regularly review progress and scale up successful strategies, making adjustments as necessary based on feedback and market developments. **Output:** Ongoing assessment reports and expanded job creation efforts based on proven successes **Timeline:** First evaluation at 2 years, then annually			**Continuous monitoring and updated if need be of skill requirements**
Economic Development	**Alignment to Economic Zones**	Currently, there are various programs and initiatives happening at a Provincial level that are not really aligned	By the end of each quarter of 2025 and in each suceeding year, realign across all MMSEZ industries of Energy and Metallurgy, Agro-Processing, Logistics and General Manufacturing to compliment renewable energy value chain	OPEX facilitation cost	1. LEDET and its agencies 2. CoGHSTA	1. SEZs (FTSEZ and MMSEZ) 2. Private enterprises	**Comprehensive Review of Existing Initiatives:** 1. Conduct a thorough inventory of all ongoing and planned initiatives. 2. Analyze initiatives to understand their objectives, target groups, funding sources, and outcomes. **Output:** A detailed report identifying overlaps, gaps, and potential areas for alignment	**Stakeholder Engagement:** 1. Identify key stakeholders in government departments, local communities, private sector and NGOs 2. Organize forums to facilitate inputs, suggestions and feedback **Output:** Stakeholder inputs consolidation and establish communication channels for collaboration	**Develop Alignment Framework:** 1. Based on the comprehensive review and stakeholder feedback, develop a framework that includes revised objectives, resource allocation, and implementation strategies. 2. Ensure the framework supports inter-departmental and inter-sectoral collaboration. **Output:** An actionable alignment framework ready for implementation	**Test Alignment Framework on Pilot Projects:** 1. Select a few initiatives for pilot testing of the alignment strategies. 2. Monitor and evaluate the implementation process, collecting data on effectiveness, challenges, and stakeholder satisfaction. **Output:** Detailed reported from pilot projects and recommendations for tweaking for full-scale implementation	**Training and Capacity Building:** 1. Identify training needs based on new roles and responsibilities outlined in the alignment framework. 2. Develop and deliver training programs that are tailored to these needs. **Output:** Trained and capable personnel ready to carry out aligned initiatives	**Implemantation Across all Projects:** 1. Use insights, inputs and successful strategies from pilot projects to guide full-scale implementation 2. Continuosly monitor progress and make adjustments when needed **Output:** Aligned provincial initiatives running effectively and collaboratively	**Continuous Monitoring and Evaluation:** 1. Establish a system for ongoing monitoring and evaluation. 2. Regularly review the impact of the alignment on achieving provincial goals, making adjustments as necessary. **Output:** Periodic evaluation of reports providing insights and further alignment of initiatives	**Continuous monitoring and evaluation of alignment framework for provincial initiatives**

Table 17 Economic Development initiatives and Activity Plan[254,255]

[254] CSIR Socio-economic benefits of renewable and storage technologies in South Africa
[255] Musina-Makhado Special Economic Zone (MMSEZ)

Just Energy Transition

Strategic Outcome	Intervention	Baseline State	Target State	Cost	Potential Stakeholders	Target Audience	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7	Activity 8
Just Energy Transition	**Reduce Carbon Emissions in Electricity Generation Mix**	Fully reliant on the grid with Limpopo having its share on CO_2 emissions from fossil fuel sources	**19% target of reduced reliance on the grid by 2030** would lead to: 1. Low performance coal fleet = 0.105 tCO_2/MWh 2. High performance coal fleet = 0.127 tCO_2/MWh This is supported by a Solar built rate of 400MW per annum in Limpopo	OPEX facilitation cost	1. LEDET and its agencies 2. CoGHSTA	1. Municipalities	**Policy Development and Regulatory Framework:** 1. Work with local and national government bodies to develop incentives for solar energy investments. **Output:** Enacted policies and regulatory guidelines **Timeline:** Finalize and enact by Q2 2025	**Monitoring IPP Solar Installations and Embedded Generation:** 1. Set up a comprehensive monitoring system to oversee IPP solar project developments and the incorporation of embedded generators. 2. Coordinate with IPPs and embedded generators to ensure compliance with regulatory standards and grid compatibility. **Output:** Detailed reports on IPP installations and embedded generation, including performance metrics and integration status **Timeline:** Establish monitoring protocols by 2026 and continue ongoing oversight	**Monitor Infrastructure Upgrades and Integration Initiatives:** 1. Develop and implement a monitoring framework that includes data collection, analysis, and reporting on infrastructure projects related to renewable energy integration. 2. Coordinate with agencies and companies responsible for these upgrades to ensure alignment with provincial goals. **Output:** Regular monitoring reports evaluating the progress, challenges, and successes of infrastructure upgrades **Timeline:** Begin monitoring in 2026, with periodic reviews and reports annually	**Monitoring and Adjustments:** 1. Develop metrics and KPIs to track the performance of solar and embedded generation systems. 2. Regularly review data and make adjustments to strategies as necessary to meet targets. **Output:** Ongoing monitoring reports and strategic adjustments **Timeline:** Begin monitoring with the establishment of protocols in 2026; adjust strategies annually				**Continuous monitoring and evaluation of CO_2 emissions and the power mix going forward**
Just Energy Transition	**Renewable Energy Skills Development**	Limited skills in the sector	**At least upskill 20% of the unemployed youth** and launch the training program by 2026 to complete the job-years target by 2030	Approximately between R11.86Million and R29.66Million for O&M of BESS and R16million and R40Million for O&M of Biodigesters (1% of workers' pay which only covers 15% of training)	1. Department of Basic and Higher Education 2. Funding Agencies 3. Private Enterprises 4. IPPs 5. Skills Development Fund 6. Sector Eduction Training Authorities	1. Limpopo labor force 2. Limpopo academic institutions	**Industry Analysis and Job Mapping:** 1. Conduct a comprehensive analysis of the current state of the renewable energy industry, including major players, technological advancements, and market trends. 2. Map out the value chain, pinpointing where new jobs can be created at each stage: manufacturing, installation, operation, and maintenance. **Output:** Detailed report on potential job creation opportunities within the renewable energy value chain **Timeline:** Complete analysis and mapping within 6 months of 2025	**Skill Gap Analysis and Training Program Development with Univem and TVET Colleges:** 1. **Collaborative Analysis:** Work closely with Univen University of Vendaland TVET colleges to analyze current workforce capabilities against future industry needs, identifying specific skill gaps. 2. **Curriculum Development:** Jointly develop training curricula that are tailored to the specific requirements of the renewable energy sector, focusing on areas such as solar panel installation, wind turbine maintenance, and energy systems management. 3. **Program Implementation:** Launch training programs across these institutions, ensuring they are accessible to a broad segment of the potential workforce, including new entrants and existing workers seeking skill enhancement. **Output:** Established training programs aligned with industry needs **Timeline:** Start analysis immediately and launch first training programs within 1 year	**Stakeholder Engagements and Partnership Formation:** 1. Identify potential industry partners, local governments, and community organizations that can support or benefit from job creation. 2. Organize stakeholder meetings to discuss collaboration opportunities and secure commitments. **Output:** Strategic partnerships that facilitate job creation and support for renewable energy projects **Timeline:** Ongoing engagement, with initial partnerships formed within 2025	**Launch Training Programs:** 1. Implement the training programs across multiple training centers to ensure wide accessibility. 2. Offer scholarships or subsidized training opportunities to enhance participation. **Output:** Operational training programs with enrolled students **Timeline:** Begin training sessions by Q1 2026	**Establish Apprenticeship and Internship Opportunities** 1. Set up partnerships with companies in the Solar PV and Bioenergy industries to host apprentices and interns. 2. Develop a matching system to place students in appropriate roles based on their skills and career interests. **Output:** Apprenticeship and internship programs with participant tracking and success metrics **Timeline:** Launch programs by Q3 2026	**Continuous Evaluation and Program Adaptation:** 1. Implement feedback mechanisms for all stakeholders including students, employers, and training providers. 2. Regularly update training programs based on feedback and evolving industry technologies and standards. **Output:** Regular evaluation reports and updated training programs **Timeline:** First evaluation by end of 2026, then annually	**Promote and Advocate for Renewable Energy Careers:** 1. Launch awareness campaigns highlighting the benefits and opportunities in Solar PV and Bioenergy. 2. Engage with community leaders and influencers to promote these sectors as viable and rewarding career paths. **Output:** Increased public and political support for Solar PV and Bioenergy skills development **Timeline:** Ongoing promotion starting in 2025	**Continuous monitoring and evaluation of training programs making changes where required, while tracking progress of the Apprenticeship and Internship programs**
Just Energy Transition	**Mitigating for Deforestation**	3.2TWh of equvalent power is being used by firewood users currently - 2024	By 2030, reduce firewood use to 2.087 TWh, fully replacing this amount with energy produced by biodigesters. Implement measures including the installation of 553,898 biodigesters to be installed for the 276,949 households using firewood, securing necessary funding by 2025-26, and establishing partnerships with local communities and energy companies by 2026.	Approximately R12 - 12.5 Billion total (Based on retail pricing there is potential for lower rates through wholesale pricing)	1. LEDET and its agencies 2. Local communities 3. NGOs 4. Academic research institutions 5. Private sector 6. Commercial Forestry and Agricultural Enterprises	1. Limpopo population	**Feasibility Study and Planning:** 1. Evaluate potential sites for biodigester installations based on geographic, demographic, and infrastructural factors. 2. Determine the technology requirements and scalability options to meet the 2.087 TWh target. **Output:** Feasibility report confirming the viability of the biodigester projects **Timeline:** Complete by Q4 2025	**Policy Development and Regulatory Approval:** 1. Work with governmental agencies to draft and pass regulations that support the financing, construction, and operation of biodigesters. 2. Secure environmental and other necessary approvals to ensure compliance and sustainable operations. **Output:** Enacted policies and obtained permits for biodigester projects **Timeline:** Achieve regulatory milestones by Q2 2026	**Partnership Development and Funding Acquisition:** 1. Identify and engage potential funding sources including government grants, private investments, and international renewable energy funds. 2. Establish partnerships with technology providers, construction firms, and local communities. **Output:** Secured financial commitments and formalized partnership agreements **Timeline:** Complete financial structuring by Q2 2027	**Infrastructure and Workforce Development:** 1. Develop or enhance local infrastructure required for biodigester projects, including roads, utilities, and communication networks. 2. Implement training programs for local workers on the installation, operation, and maintenance of biodigesters. **Output:** Ready infrastructure and trained workforce for project commencement. **Timeline:** Begin infrastructure upgrades in 2027 and complete workforce training by the end of Q1 2029	**Biodigester Installation and Commissioning:** 1. Coordinate the logistics and scheduling of construction to ensure timely completion of installations. 2. Oversee the installation process, ensuring all engineering and safety standards are met. 3. Conduct testing and commissioning of biodigesters to ensure operational efficacy and safety. **Output:** Operational biodigesters producing 2.087 TWh annually. Timeline: Start installations in early 2029 and complete commissioning by the end of 2030	**Monitoring and Maintenance:** 1. Implement a monitoring system to track performance, energy output, and environmental impacts. 2. Set up regular maintenance schedules to ensure long-term functionality and safety of the biodigesters. **Output:** Fully operational, efficient, and safe biodigester facilities **Timeline:** Continuous from commissioning, with the initial review Q1 2031		**Continuous monitoring and evaluation of firewood use within the province, coupled with training and maintenance of infrastructure**

Table 18 Just Energy Transition initiative and Activity Plan

ANNEXURE C: DETAILED ACTION PLANS AND CAPACITY BUILDING

Energy Security

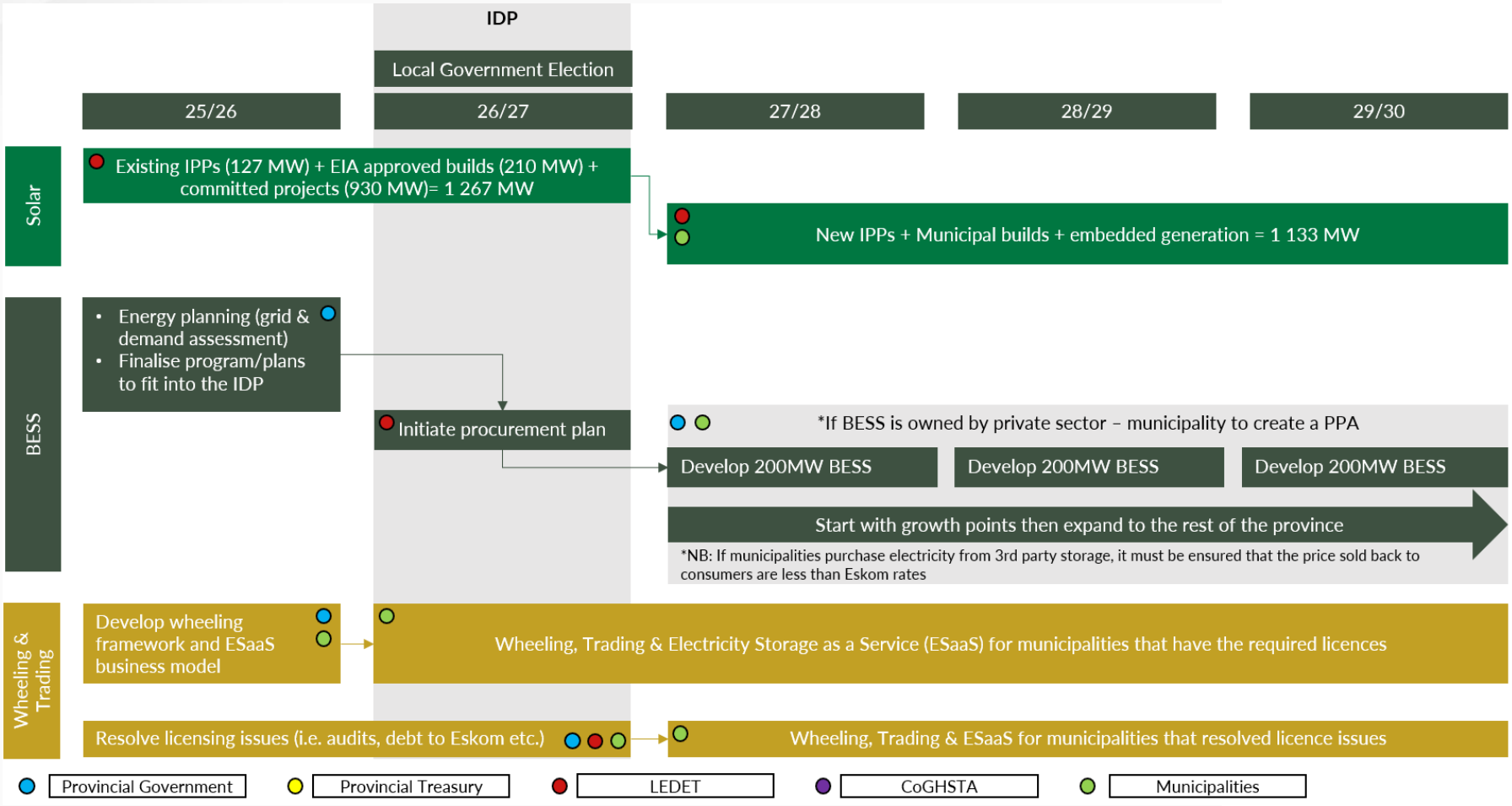


Figure 115: Detailed action plan – Energy security

Economic Development

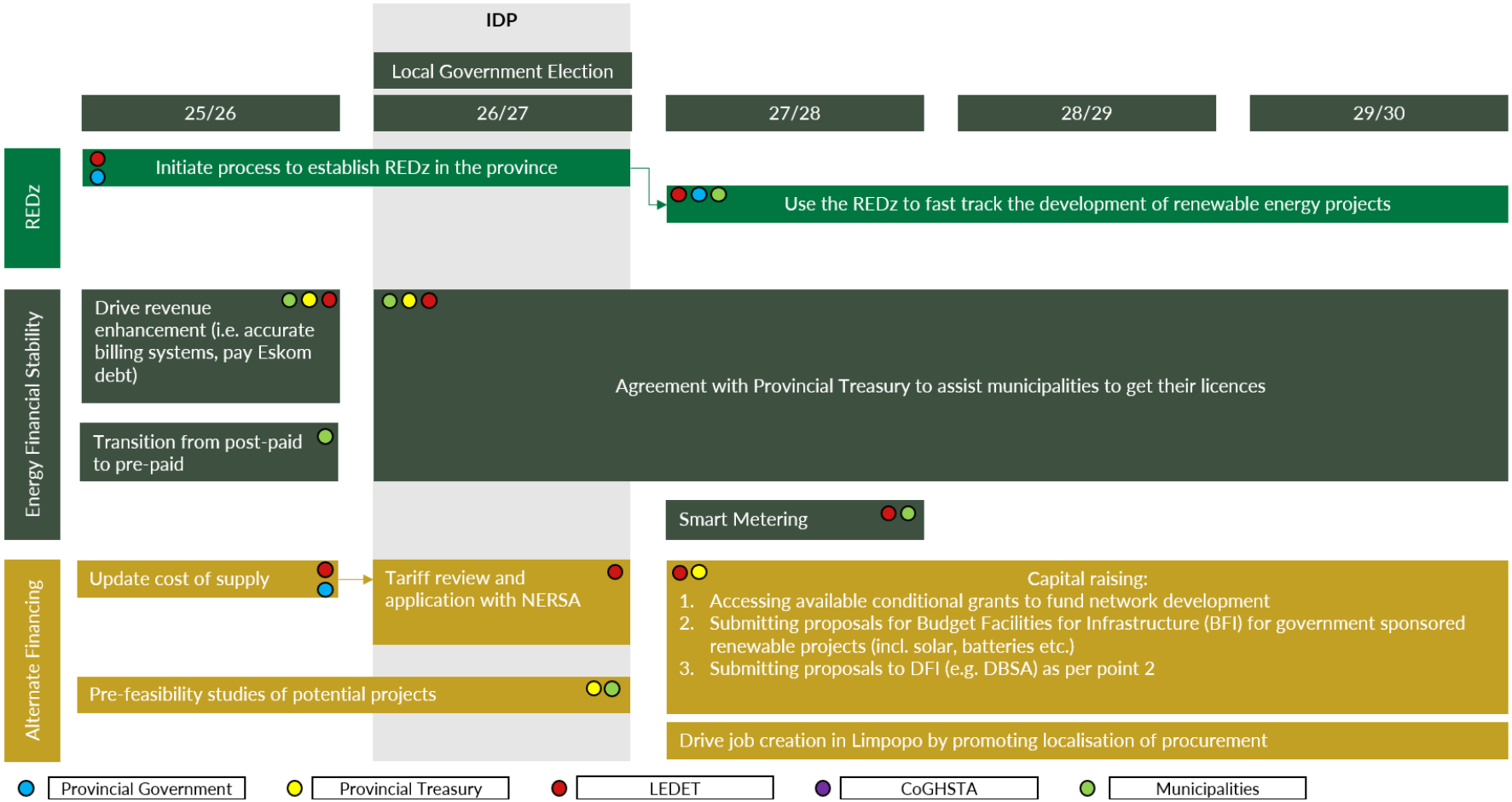


Figure 116: Detailed action plan – Economic Development

Just Energy Transition

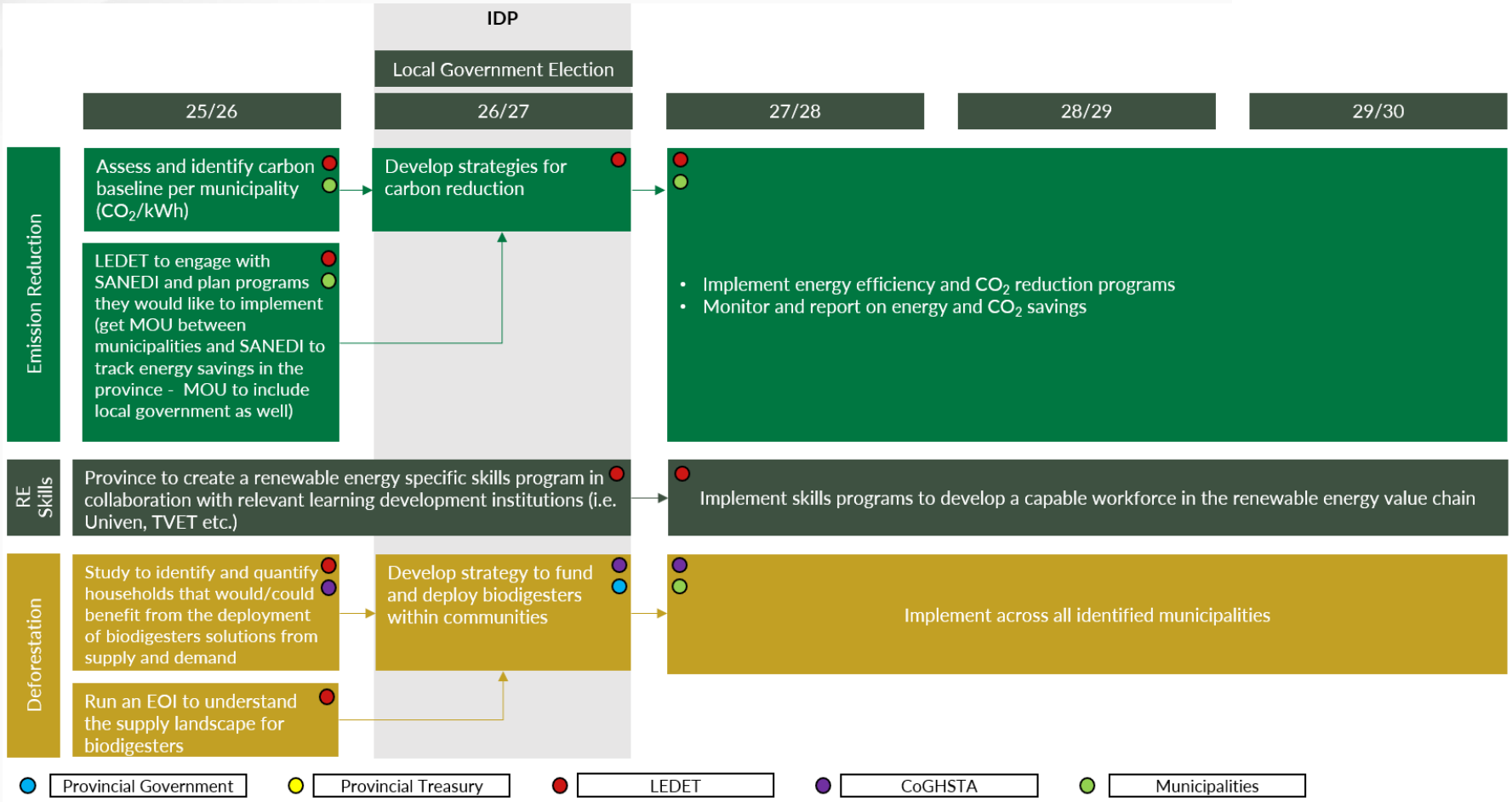


Figure 117: Detailed action plan – Just Energy Transition

Municipality Capacity Building

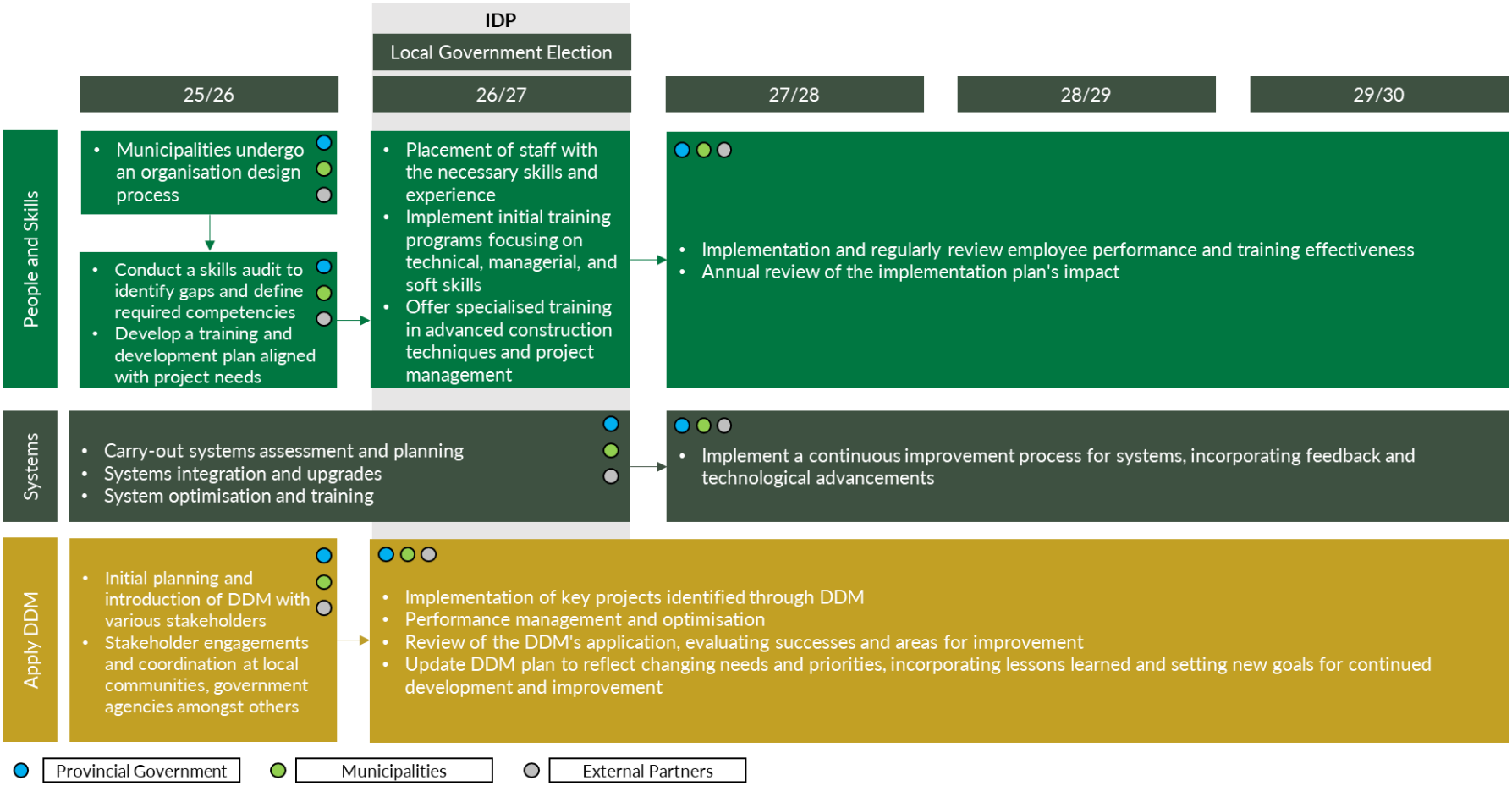


Figure 118: Detailed municipality capacity building framework

ANNEXURE D: REVIEW OF MUNICIPAL COLLECTION MODEL

As indicated in the strategy, there is a critical need for an enhancement of the revenue management systems of our municipalities to derisk the execution of the strategy. In so doing, we review the current modality of revenue collection and the need for a shift to enable investor confidence and stakeholder support towards the delivery of the strategy.

The Traditional Municipal Collection Model and its Disadvantages

The flow of funds in a traditional municipal model would look something like the below schematic:

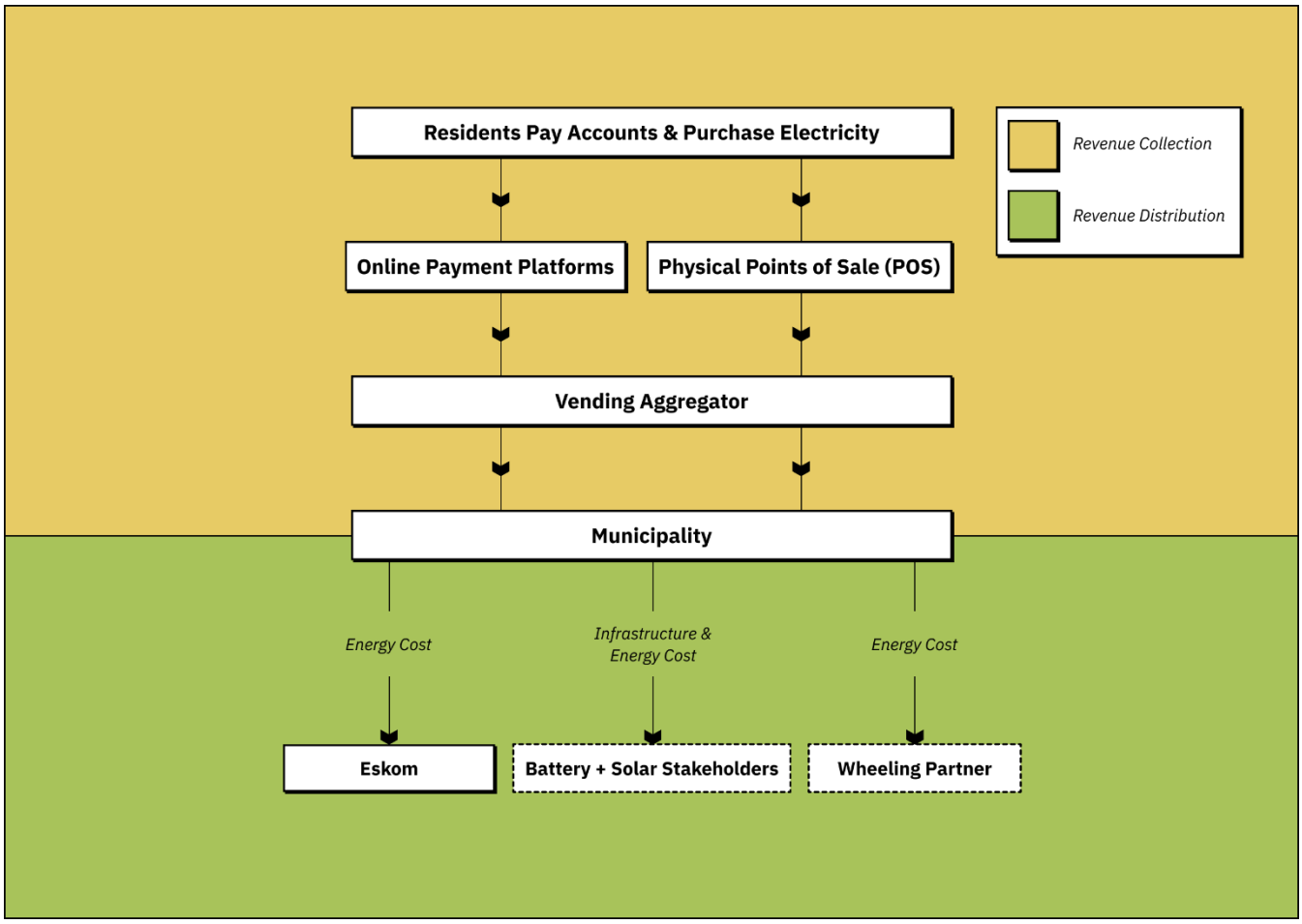


Figure 119: Current revenue collection system

As can be seen above, this traditional structure has more levels for funds to move through and places the responsibility and administrative burden on a municipality to pay all the suppliers and stakeholders involved.

Several disadvantages exist with this structure:

1. Because online and physical point-of-sale (POS) payment channels are seldom integrated into the municipality's back-end system, residents cannot be shown their outstanding account balances and prepaid electricity cannot be used as leverage for residents to settle these accounts. Thus, with the traditional municipal model, revenue collection rates are often much lower than they could be.
2. There are additional administrative and financial burdens placed on the municipality who will be responsible to repay financiers and settle energy suppliers on a monthly basis.

3. Having an extra layer for funds to flow through opens the door for settlement complications and delays.
4. Suppliers and investors are more hesitant to invest and participate in projects where they are settled by municipalities, as this typically comes with a higher degree of risk for them (municipalities do not have a good track record when it comes to the payment of energy suppliers like Eskom).
5. Should the traditional model be kept in place, additional energy sources will be managed in isolation, making it much tougher for sources to be switched dynamically to maximise profitability.

Ultimately, if each part of the municipality's renewable energy structure is handled in isolation, several risks may arise. These include miscommunication, mismanagement of funds, and payment discrepancies due to unsynchronised processes and/or delayed reports.

Integrated Revenue Management Solution

In response to the above challenges, a framework has been proposed to enable and alternative approach to revenue collection, particularly in this evolving market environment. This approach is underpinned by certain best practices as detailed below:

Table 18: Best Practices to Ensure the Achievement of Green Objectives

Best Practice	*Description*
1. Ensure your municipality is in good standing.	• This entails good standing with SARS and all the municipality's creditors and suppliers. It also includes clean audits and financial compliance. • This is necessary to ensure stakeholder buy-in and cooperation. It also simplifies the obtaining of funding and investment for renewable energy projects, as it's essential for investors to collaborate with municipalities who operate stable and sustainable financial operations.
2. Improve and maximise municipal revenue collection rates.	• Effective revenue collection is essential to service delivery, and renewable energy projects cannot be properly implemented or maintained if municipal collection rates are low. • Stakeholders will want to see that the municipality is collecting revenue well; this provides great assurance to investors. Policies and/or systems need to be in place to maximise municipal revenue collection and activate previous non-payers of rates and taxes (villages on tribal concession lands, etc.)
3. Use the sale of prepaid electricity as leverage to achieve higher revenue collection rates.	• Prepaid electricity purchases can be used to incentivise customers to pay their municipal accounts. If a resident does not pay their municipal accounts, prepaid electricity purchases must be disabled or considerably limited for them, until the necessary settlements are made. • This mechanism is widely used across the country in various shapes and forms and has been very successful.
4. Be transparent about the flow of funds, ensuring that every Rand is accounted for.	• It's essential to provide a clear and detailed account of how money moves in and out of each link in the value chain. Important aspects here are detailed records, regular reports, open communication and clear audit trails.
5. Dynamically switch between all available energy sources to maximise	• Energy must always be sourced at the lowest possible rate. With battery storage capacity, solar generation and wheeled energy available, in addition to the various tariffs at which the municipality can purchase electricity from Eskom, this will require a high level of integration and expert arbitrage

Best Practice	*Description*
profitability for the municipality.	functionality. Proper management on this front will lead to major financial benefit for the municipality and the ability to further expand renewable energy initiatives.
6. Pay various suppliers and/or vendors from their respective income streams.	• Ringfence revenue collected from a given source to settle corresponding suppliers. Paying suppliers and vendors from their respective income streams will involve managing cash flow efficiently to ensure timely payments without compromising operational stability.
7. Appoint an independent third-party escrow service provider to facilitate and manage the flow of funds.	• This third party must secure funds to distribute to all parties involved in the implementation and execution of renewable projects and initiatives. They must ensure that funds are paid to the correct suppliers and stakeholders, whether it be public and/or private role players. • This will give assurance to municipal stakeholders, national treasury (if applicable) and private sector investors that funds will be allocated appropriately and in a timeous manner.
8. Engage private sector for consultation on pricing and time-effective implementation.	• Gain insights and recommendations on how to price products and services competitively, and ensure that projects are executed timeously so that renewable benefits can be enjoyed as soon as possible.

Going forward, municipalities will have multiple energy sources, each with its own unique cost and settlement process. Settlements will need to take place regularly and timeously. To this end, a single platform must manage all relationships and integrations so that energy revenue streams and supply pipelines can be viewed and managed holistically and optimised for profitability.

Quick and accessible information is also essential for the proper management of renewable projects and operations. A single point of contact will simplify queries and support for municipalities, as they will have a centralised point for utility reports and the revenue flowing in from each respective energy source (both traditional and renewable). Thus, easy access to all required information and financial records will be available, without having to request external reports or wait for feedback from isolated role players.

An integrated revenue solution provider will need to be appointed who handles customer purchases and payments and also connects and interfaces with all the parties and suppliers involved in the municipality's energy network.

Below is a visual schematic of what the flow of funds with an integrated solution as described above can look like.

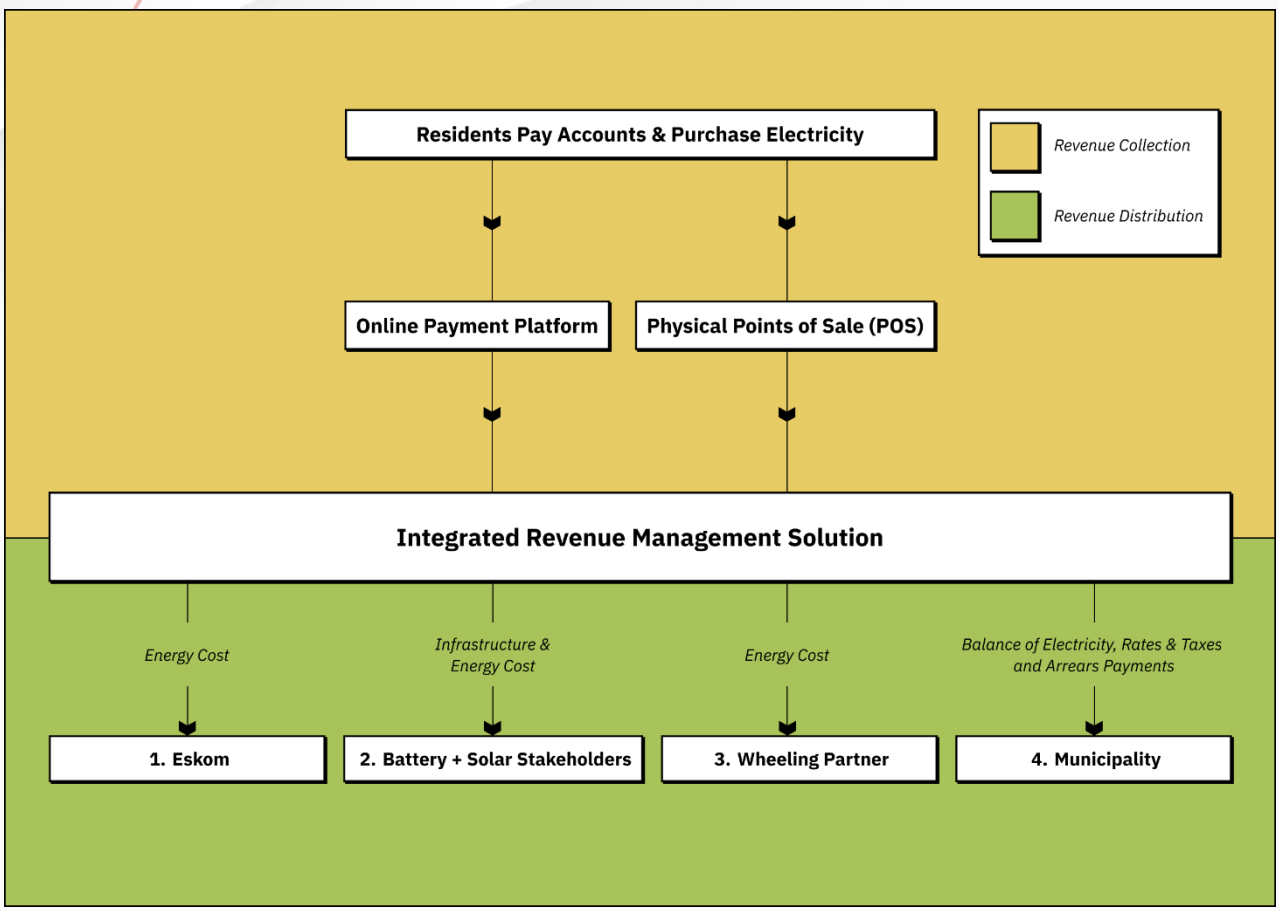


Figure 120: Alternative Revenue Collection System

Some important requirements for this integrated revenue management solution provider are the following:

1. It must be integrated into online and POS payment channels through which revenue will flow (fulfilling the role of a Vending Aggregator in a traditional municipal model, as shown on the next page).
2. It must be integrated into the municipality's back-end system provider to show residents their real-time account balances and collect revenue effectively.
3. It must keep track and report on what percentage of electricity sold is coming from which energy source (Eskom, Battery, Solar, Wheeling).
4. It must provide transparency and a guarantee to all partners and investors that revenue will be distributed correctly and that timely settlements will be made.