ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

An Investigation into the Models for Financing Renewable Energy Production in Low-Income Settlements in Gauteng, South Africa

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Publication Date:2025/09/12

Abstract: South Africa is challenged by the lack of stable modern electricity which is essential for economic and social development. Many Gauteng communities, especially in rural, informal, and low-income settlements are not connected to the national grid i.e., Eskom, while 39% of the province residents are in the dark relying on paraffin and gas for surviving the cold winter. Further, these two components increase the number of fire fatalities in the informal settlement and the hiking price of electricity, adding to the burden to the poor. The study reviewed existing literature on the available financing model renewable energy and collected primary data in the form of structured interview questionnaires from industry participants and stakeholders.

This study focused on models of financing RE in the country are analysed, with focus on suitable financing model and source of financial exposure the project finance, green finance, public, private and partnerships, government grants and private investors also the direct foreign investors, resulting in a mixture of financing model. The study used the mixed methodology approach to develop a framework through which REP development is related to the perspectives of financiers and policymakers to enable reliable and useful research findings. This divergence presents a key obstacle to financing renewable energy.

Further, results show that traditional financing methods have been largely ineffective in promoting the development of RE, hence, the need for innovative financing channels to increase RE development in Gauteng and South Africa. Also, the results revealed that financiers of green energy consider renewable energy to be highly risky even when supported by government policies. Therefore, the study proposes financing models that amalgamate financiers into a small financing consortium using mixed financing models to fund localised RE projects, the kind of models that spread risk among several investors, thereby, reducing the potential risks of investments while delivering on the objective and benefits of tax rebates or other allowance when investing in RE.

Keywords*: Direct Foreign Investment, Financing Model, Gauteng, Public-Private Partnership, Renewable Energy, Renewable Energy Producers, Tax Rebates, South Africa.*

How to Cite: Maluleke V; Dlamini C. (2025) An Investigation into the Models for Financing Renewable Energy Production in Low-Income Settlements in Gauteng, South Africa. *International Journal of Innovative Science and Research Technology*, 10(8), 2927-2944. https://doi.org/10.38124/ijisrt/25aug358

I. INTRODUCTION

The cost of electricity for a residential dwelling in South Africa has substantially increased in recent years. The average percentage of annual expenditure on electricity costs for households has risen from 7% in 2007 to 20% in 2014, (Energy Intensive User Group of Southern Africa, 2014). The current commonly used electricity sources are onsite diesel generators and the electrification grid of the national utility supplier, Eskom (Boyse, Causevic, Duwe & Orthofer, 2014). Electricity price escalations, past and future, will damage the global competitiveness of these companies (Creamer, 2012). While considering how the global electricity supply and demand are playing out in South Africa, where the electricity system to date has been controlled by a state-owned, largely coal-dependent monopoly utility that owns the transmission grid is responsible for 95% of generation and 60% of the distribution. Meanwhile, municipalities are responsible for the other 40%. South Africa's electricity system has been historically determined by the country's abundant coal supplies, and complex interactions between its social, political, and economic institutions, networked infrastructures, and technological capabilities (Baker, 2016).

In addition, renewable energy sources are a crucial component of many small economies. There is an important relationship between renewable energy resources and growth. Faster population growth increases and then pressures the limited resources so reducing per capita growth. Change in the production structure, technological progress and switching between the different renewable energy sources can create and enable dependence on natural resources for

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

economic growth. Either decreasing the relative price of renewable energy relative to fossil fuels or by increasing demand for electricity generated from renewable sources, such policy measures will provide increased returns by the identification of more efficient forms of electricity generation using renewable energy sources (Johnstone et al., 2010). About 48% of South Africans are considered 'energy poor', meaning that they do not have 'access to adequate, dependable, safe and environmentally benign energy' (Sustainable Energy Africa (SEA), 2015). Within this complex milieu, in recent years, South Africa has witnessed the rapid introduction of rooftop and ground-mounted solar PV by commercial, industrial, and high-income residential households. The many thousands of grid-tied distributed installations, each less than 1 MW and typically much smaller, are collectively termed small-scale embedded generation (SSEG) or distributed generation. Despite the absence of an appropriate national legal and regulatory framework thus far, SSEG has been installed by commerce, industry, and wealthy households, primarily in response to recurrent crises in electricity supply, rising tariffs, and rapidly declining prices for solar PV technology.

In general, urban municipalities within Gauteng and the Western Cape are more dependent on electricity as a source of revenue than peri-urban and rural ones (Statistics South Africa, 2015b). However, some of the smaller municipalities still earn nearly half of their total income from electricity sales, including uMhlathuze, Umtshezi, KwaDukuza in KwaZulu-Natal, Langeberg in the Western Cape, and Tlokwe in the Northwest Province (Grant, 2015). Eight metropolitan municipalities in South Africa have exclusive municipal and legislative authority in their areas. These are the City of Tshwane, City of Johannesburg, Ekurhuleni, eThekwini, Mangaung, Buffalo City, Nelson Mandela Bay, and the City of Cape Town. These 'metros' "constitute the country's largest cities with over 500,000 inhabitants and represent 'intense nodes of activity and energy consumption, accounting for 60% of total economic activity, 42% of the national population and generating 39% of national energy-related carbon emissions" (Wolpe & Reddy, 2016, p. 9).

A. Background

Given this, we now consider the evolution of electricity access in South Africa, particularly since the end of apartheid in 1994. Access to electricity in South Africa, as with access to other basic services such as housing, education and water is paralleled by high levels of poverty and socio-economic inequality. Under apartheid, industry, commerce, and nearly all-white households including remote farms enjoyed secure and reliable electricity connections, while few black townships and informal settlements had access. Until 1994, approximately one-third of the population was connected to the grid. During the transition to democracy, access to affordable electricity became 'a basic need and basic right' with high political and cultural significance (Mayr et al., 2015) and was central to the post-apartheid government's Reconstruction and Development Programme (RDP). Consequently, low-income households have typically aspired to a grid connection rather than off-grid alternatives such as solar home systems and solar water heaters (Wlokas, 2011). Following the transition to democracy, the national electrification programme under the RDP saw a dramatic rise in domestic connection rates, assisted by surplus generation capacity and low electricity prices, which saw 87% of households connected to the grid by 2012 (SEA, 2015).

Yet access to electricity is not reflected in electrification rates alone, given that many households cannot afford to use the electricity to which they are connected, despite the provision of a basic allocation of free electricity 3 million low-income houses are multiple fuel users, prioritising other energy sources such as paraffin, wood and coal over electricity which leads to related problems such as air pollution, respiratory illness, and shack fires. By the early 2000s, progress in the national electrification programme had started to slow for various reasons, including the cost of additional infrastructure required to connect sparsely populated rural areas (Bekker et al., 2008, p. 3132). South Africa faces a large and rapidly growing urban population. As a legacy of apartheid era planning, South African cities are highly segregated and of low density, which presents significant financial and infrastructural challenges for electricity distribution. It is indicated that sixty-five per cent of the country's 52 million people live in urban areas, a figure anticipated rising to 70% by 2030" (Wolpe & Reddy, 2015, p. 5).

Furthermore, "forty per cent of the urban population lives in the country's eight metropolitan municipalities, which consume 36% of national electricity consumption" (SEA, 2015, p. 21). One measure to address electricity access and affordability is the state's free basic electricity (FBE) allowance, introduced in 2004 with the aim to provide 'electricity to all' through the provision of 50 KWh per month of free electricity to low-income households. In addition to illegal connections, Eskom also refers to a culture of non-payment including in Soweto, Sandton, and Midrand. Subsequent disconnections carried out by Eskom or municipalities have affected millions of low incomes households (Clarke & Yelland, 2016). Finally, rising consumer tariffs have contributed to incentives for wealthier residential and commercial consumers to establish their own source of solar PV generation, thereby, reducing revenues of either Eskom or the municipal distributor. The following section summarises the political, economic, and regulatory context out of which this distributed generation has emerged, including an entrenched and complex crisis within the utility Eskom failed attempts at sector reform and the evolving dynamics of electricity planning.

B. Renewable Energy in South Africa

To deal with the energy crisis facing the country, inaccessibility of electricity to the rural and remote area dwellers, and the problem of environmental degradation from over-dependence on coal, South Africa adopted enabling policies framework to increase the share of renewable energy in the national energy mix as shown in Figure 1. The feasible resources of renewable energy in South Africa are solar, wind, biomass, geothermal, hydropower, waste to energy, and tidal (wave) energy. Their potential varies from one province

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

to another. Except for KwaZulu Natal and the Mpumalanga provinces which have the highest potential for biomass, the other seven provinces have the highest potential for solar energy (DEA, 2017). The wind has the second-highest potential in the three Cape provinces, biomass has the second-highest potential in the Limpopo province, and hydro has the second-highest potential in the Free State Focus. In this paper, it is the solar and wind energy implementation in South Africa that has a large potential for power generation.

The Government's commitment to promoting RE technologies goes back to the post-apartheid 1996-Constitution of the country from which several policy documents have emerged namely, the 1998 White Paper on Energy Policy (WPEP), 2003 White Paper on Renewable Energy (WPRE), 2011 White Paper on National Climate Change Response Policy (WPNCCRP). The 2011 National Development Plan (NDP, 2011) also reflects the Government's commitment to RE technologies for sustainable development. As a percentage of GDP, South Africa was the fourth largest investor in renewable power in the world in 2012. In 2012, 16.9% of total energy consumed came from renewables which were mostly from the combustion of traditional biofuels for heating and cooking. In 2009, the National Energy Regulator of South Africa (NERSA) announced renewable energy feed-in-tariffs (REFIT), differentiated by technology, for private producers to inject electricity into the national grid. The feed-in-tariffs were replaced by a competitive bidding process in 2011 which has two phases, the Qualification phase, and the Evaluation phase (NERSA, 2009).

The total allocation of RE generation capacity to over 92 power producers by the Renewable Energy Independent Power Producers Procurement Program (REIPPPP) in five rounds of the bidding process up to 2014 was 6,300MW, mainly from wind and solar generation. Most of the allocations made have not been awarded to the producers by the Department of Energy (DoE). Total 1860 MW RE generation capacity had commenced commercial operation by mid-2015 (NERSA, 2009).

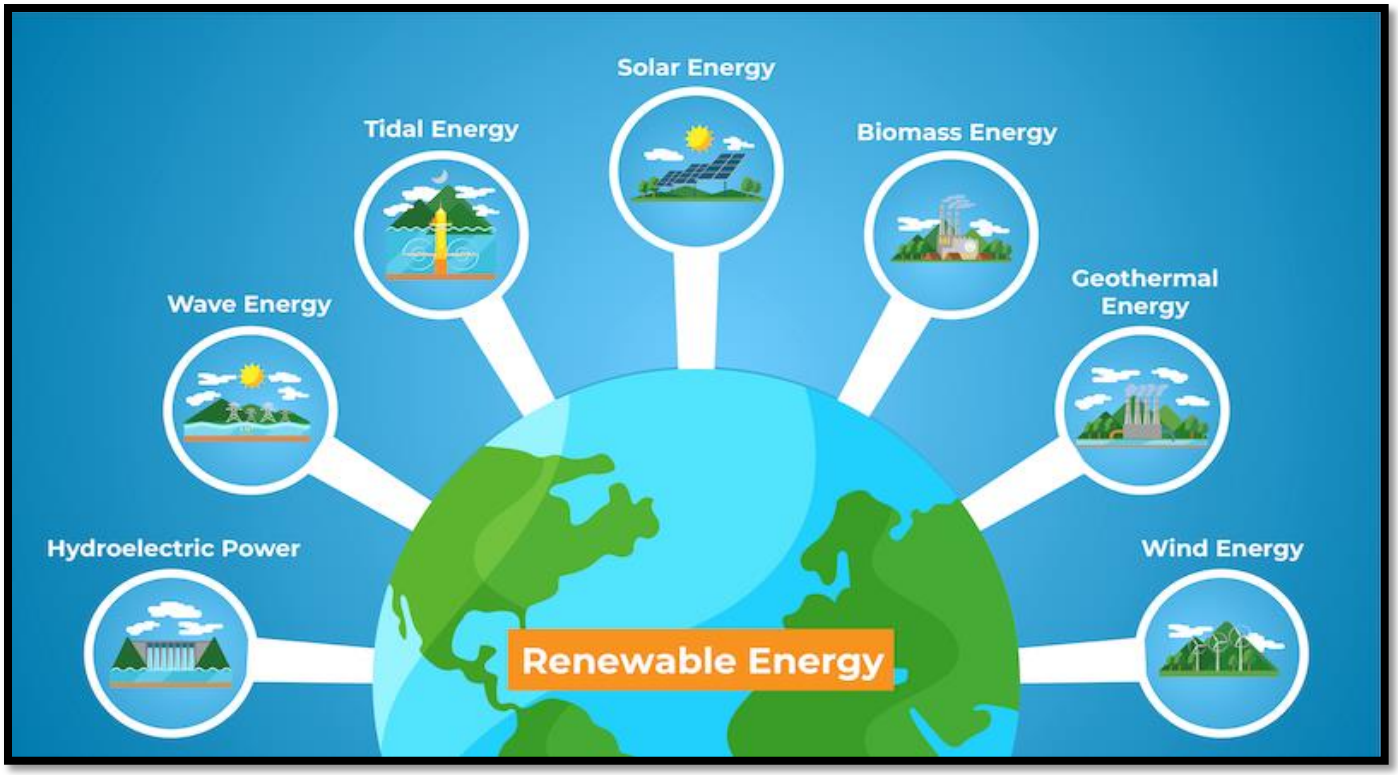

Fig 1 Source of Renewable Energy in South Africa
Source: Greenesa (2021).

C. Renewable Energy in Gauteng

Gauteng as a province covers an area of 18 179 km2 and is home to over 11 million people. This population is spatially organised in a sprawling region of geographically distinct cities and towns. In this polycentric region, the most recognisable cities are Johannesburg and Pretoria, but there are also a number of other significant urban centres (Green Strategy 2011). Gauteng houses have the 22.4% of the total population in the country, making it the smallest Province in South Africa, yet with the largest population and largest contribution. This population is also rapidly expanding not only due to natural births but by in-migration to Gauteng and its surrounding areas, resulting in a 13.61% population change between 2001 and 2007. As a fast-growing polycentric city-region, Gauteng's requirements for basic services such as food, water, and sanitation, are rapidly increasing, and the province is required to roll out services, infrastructure, and housing to meet growing demand (Green Strategy, 2011).

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II. LITERATURE REVIEW

A. Overview

Energy poverty remains one of Africa's most significant barriers to socio-economic progress. More than 600 million households lack access to essential energy services and population growth is expected to perpetuate existing shortages in the coming decades. With Eskom (state-owned electricity supplier) struggling to provide electricity to industrial development zones/workplaces that have a negative impact on economic activities (Statsa, 2012). While the energy industry contributes around 80% toward South African total greenhouse gas emissions of which 51% are from the electricity that was generated from the liquid fuel production alone and the distributors aim to assist the state-owned entities with the service delivery or public delivery (IRP, 2019).

South Africa through Eskom participates and trades electricity through the South African Power Pool (SAPP). While the African continent is rich with primary energy resources, there is limited energy trading between African countries. South Africa through Eskom imports electricity from Cahora Bassa dam in Mozambique. South Africa through Eskom also exports electricity to SADC countries but with obstacles in free trade agreements (IRP, 2019). Although there are constraints to investment in new and renewable sources of energy, the potential demand exists for financing various activities related to exploration, exploitation, development, and distribution of energy, generated from alternative sources. For most developing countries, however, the problem is one of the constraints rather than opportunities (Ali, 2016).

RE development may be financed using different models and sources. In this study, some use the model whereby two different mechanisms are used to classify the traditional categories (old model) or conventional financing and the current innovative/technological financing model (Shrestha, 2007). Finance plays a critical role in the delivery of REPs that possess the capacity to impact socio-economic development positively while contributing to reducing GHG emissions. Most REPs have high upfront costs associated with the procurement of equipment, feasibility studies, land purchase or lease agreements and multiple service contracts for developing a project. When a provincial, state, or national policy for developing renewable energy is lacking, it is common practice for lenders to set interest rates on bank loans for REPs at prohibitively high levels, based on perceived risks associated with financing REPs in these situations (Nelson & Shrimali, 2013).

B. Theoretical Framework

The study groups were selected mainly for their knowledge of RE financing. Analysis of the qualitative data was used to explain the broader perspective of the actual reality obtained from analysing the quantitative data collected from stakeholders and financiers of REs.

C. Renewable Energy Challenges

- Insufficient public funding of regional power infrastructure is a determinant for entrenched social inequalities.
- Inadequate electricity supply restricts the availability of lighting, industrial innovations, and development of social institutions, which moderates the quality of education and pace of economic development. Several studies elucidate a co-integration between energy accessibility, consumption, and per capita incomes.
- Frequent power outages and supply constraints have been associated with the large dependency of costly captive diesel generators.
- High mortality rates throughout the continent have also been attributed to the persistent reliance on biofuels by households.
- The shortage of public investment in the power sector reflects macroeconomic and microeconomic challenges, including subdued capital market development, ineffective fiscal management, and the concentration of state ownership in the sector.
- Whilst public funding constitutes the primary source of financing for power projects in the region, investment in new capacity has been limited.

D. Source of RE Financing Model

- *Empowerment Funding*

The other debt financing requirement, to fund empowerment equity stakes, is relatively expensive and already in short supply. Whether black economic empowerment business partners or community trusts, empowerment entities often have their equity stakes debt-financed, placing 10% in cash and leveraging the remaining 90%. Currently, the IDC and DBSA are providing most of this financing through either preference shares or standard loans. (DEA, 2017).

- *Debt Financing*

To date, local banks have taken different views regarding RE financing. Nedbank, the largest bank by participation and representing about R18 billion in REIPPPP-related project debt, has chosen to hold its own exposure to date. Standard Bank and RMB, on the other hand, have chosen to distribute their debt through selling it off (debt syndication) (DEA, 2017).

- *Private Financing (Private, Public Partnership)*

The funding source and shareholding highlight the broad spectrum of participation and benefits that emanate from this investment. Of this total investment, R48.8 billion originates from foreign investment and financing (Figure 2). This represents more than double the inward FDI attracted to South Africa during 2015 (R22.6 billion) as reported by the South African Reserve Bank (SARB) (DEA, 2017).

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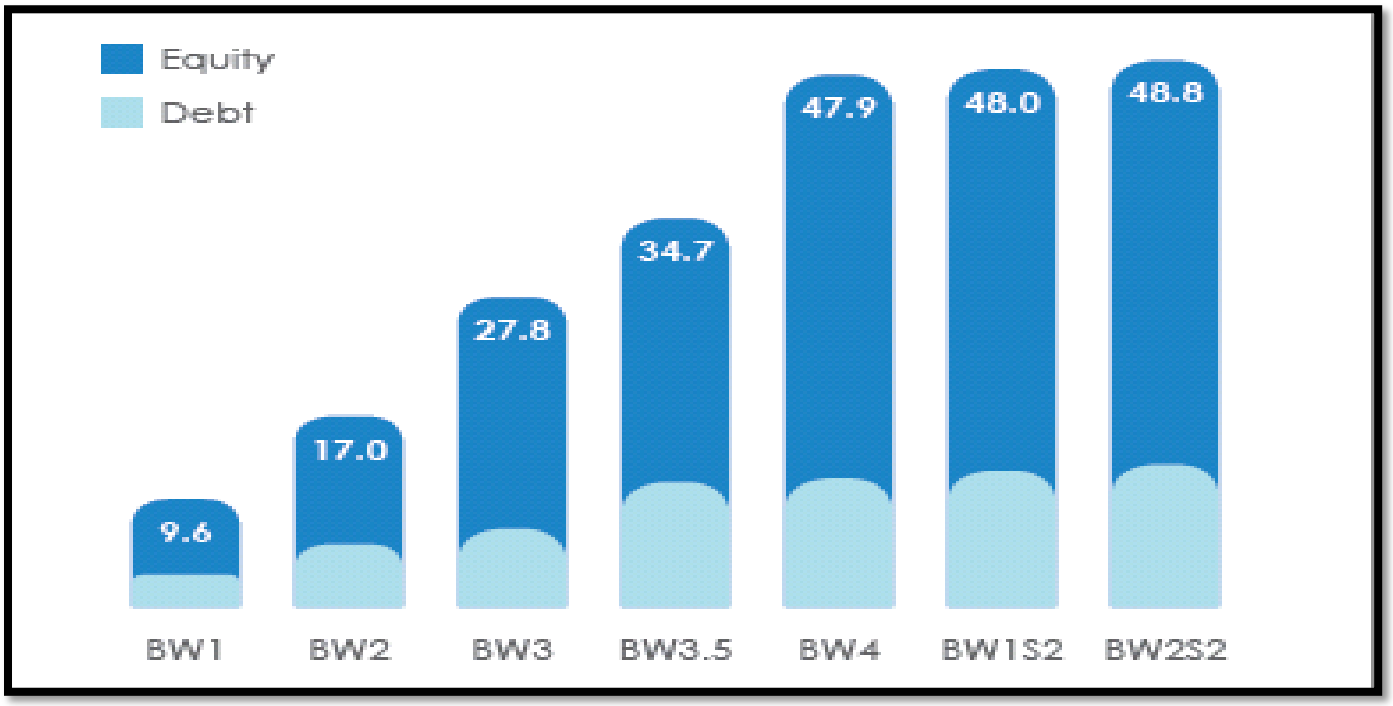

Fig 2 Total Foreign Direct Investment Attracted of Total Committed Investment.
Source: DEA (2017).

➢ *Government Grants*

Core players include the departments of Trade and Industry, Energy, Environmental Affairs and Public Enterprises, as well as Eskom and the National Energy Regulator. Other entities are critical to implementation, notably local and provincial Governments, which handle rezoning applications and permitting (DEA, 2017).

➢ *Municipality Infrastructure Grants*

Municipalities are required to develop an approved infrastructure capital plan that is linked to the integrated development plan to access this grant funding. The Department of Cooperative Governance and Traditional Affairs (COGTA) administers the fund and coordinates support at the national, provincial, and local levels for the programme (DEA, 2017). Gauteng Province, for example, announced in 2015 that it would be installing rooftop solar panels on the eight million square meters of rooftop space available across Provincial Government buildings. This is expected to provide between 300 MW and 500 MW generation capacity. The Gauteng Department of Infrastructure Development initiated the Rooftop Solar Photovoltaic Rollout Programme under their integrated demand management plan in 2015 and registered it as a potential Public-Private Partnership with National Treasury (NT) (DEA, 2017).

Table 1 Summary of Literature Review for Financing Model

Study	Study Topic	Countries Covered	Period Covered and Frequency	Methodological Issues	Summary of Findings
Rivhatshinyi N Kamara (2016)	Comparative study for renewable energy financing option in Brazil, China, Indian and South Africa.	4 Countries (China, Brazil, Indian and South Africa.)	2004-2016	Multivariable Model (M-Egarch) with constant correlations.	The options employed: • Decrease credit risk and transaction cost for the renewable energy activities. • The use of concessional debt at rates below market rates to incentivise growth.
Xiaohuan Lyu and Anna Shi (2018)	Research on the Renewable Energy Industry Financing Efficiency Assessment and Mode Selection.	1 Country (China)	2008-2015	BC2 Model (Variable Returns to Scale) and C2R Model (Constant Returns to Scale)	The study findings: • Renewable industry has been ignored resulting in redundancy and limited focus on financing options.

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C. Ojia, O. Soumonnib, K. Ojah (2016)	Financing renewable energy projects for sustainable economic development in Africa.	Southern Africa and North Africa. East Africa, West Africa, and Central Africa	2012-2015	Chi-square test is essentially an analysis of the associations between selected (test) variables (Quantitative)	• Project finance is the preferred option of financing among Renewable Energy Projects (REP) financiers, while REP developers mainly prefer corporate finance. • Financing and investment barriers such as the lack of appropriate credit reporting systems and project scalability.
CK Oji (2015)	Models of financing renewable energy for sustainable development: An African perspective.	22 African Countries. (Including South Africa)	1993-2009	Combination of Quantitative and Qualitative Methods.	• Traditional financing methods have been largely ineffective in promoting the development of REPs in African countries
S Schwan (2011)	Overcoming Barriers to Rural Electrification	1 Country (Bangladesh)	2011	Combination of Quantitative and Qualitative Methods.	• Micro-energy loans overcome the lack of access to credit and spread high initial upfront costs over a longer period, which enhances the affordability of micro-energy systems.
GK Sarangi (2018)	Green energy finance in India: Challenges and solutions.	1 Country (India)	Case Study based REP Finance in India.	Qualitative method.	• Government should act as a facilitator and should devise innovative policy mechanisms not only in terms of introducing innovative financing instruments but also creating a conducive environment that minimises the associated risk factors.
SC Bhattacharyya (2013)	Financing Energy Access and Off-grid Electrification: A Review of Status, Options and Challenges	Focus on African Countries.	2009-2013	Combination of Quantitative and Qualitative Methods.	• The funding gap will be more acute in the least developed countries where the energy access level is very low and where the traditional barriers to investment are more profound. • The study highlighted that even the multilateral funding agencies actively involved in the development of poorer countries have not paid adequate attention to energy access funding and have focused on large projects and large countries.
Sebastian Fritz-Morgenthal, Chris Greenwood, Carola Menzel, Marija Mironjuk, Virginia	The global financial crisis and its impact on renewable energy finance	3 Countries (Germany, Italy, and the Czech Republic)	2008	Combination of Quantitative and Qualitative Methods.	• The majority expects that the market volume of private equity, venture capital, project finance and capital markets will decrease further in the foreseeable future, while government financing of renewable energy will increase.

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Sonntag-O'Brien, (2009)					
Yose Rizal Damuri Raymond Atje (2012)	Investment Incentives for Renewable Energy: Case study of Indonesia.	1 Country (Indonesia)	2002	Desk research and structured interviews. (Qualitative method.)	• The Indonesian government's continuing subsidisation of gasoline and under-pricing of electricity generation provides incentives in direct contradiction to investment incentives for renewable energy. • Lack of identified controls/measures to help project developers apply for finance or to help banks assess renewable energy projects.
Kenny Baumli Tooraj Jamasb (2020)	Assessing Private Investment in African Renewable Energy Infrastructure: A Multi-Criteria Decision Analysis Approach	5 Countries. South Africa, Kenya, Nigeria, Cameroon, and Tunisia	2020	Desk research and structured interviews. (Qualitative Method)	• Public/Government funding in the region is not sufficient to provide basic energy services and to match the expected increase in demand correlated with population growth in the coming decades. • South Africa emerged as the preferred investment destination for renewable energy projects, followed by Kenya, Tunisia, Nigeria, and Cameroon, respectively.

III. PROBLEM STATEMENT AND OBJECTIVES OF THE RESEARCH

A. Problem Statement

As a fast-growing polycentric city-region, Gauteng's requirements for basic services are such as food, water and sanitation, electricity, and other service delivery outputs like roads, housing, schools, and proper quality health care. The nature of this service delivery has largely omitted more sustainable service delivery options and mechanisms, and the ways these infrastructure investments can create jobs (Green Strategy, 2011). Access to electricity remains a challenge for the residents of Gauteng as the sole provider, Eskom supplies municipality, while only 61% of the province population have access to the paid electricity and the remaining 39% are in the dark relying on paraffin and firewood for surviving the winter added to the burden of hiking electricity tariffs and scheduled load-shedding (DEA, 2017).

It is stated that the power giant "Eskom's immediate response is to safeguard its assets from repeated failure and explosions as a result of overloading caused by illegal connections, meter bypasses and tampering with electricity infrastructure that is on an increase," resulting in revenue leakage for the power supply and affecting the maintenance of the power station (Business Time, 2020). Since 2008, the country faced major challenges in the energy sector, the country experienced high usage of the increase and fuel petrol prices, energy is important to the survival of the Gauteng province (GIES, 2010). The city is struggling to electrify every dweller (either formal or informal) and also to curb the illegal electricity connections which bleed the city income (revenue leakage). Also, the sole power supply having challenges in providing the resident with electricity is due to load shedding and the grid has insufficient supply voltage (DEA, 2017).

B. The Objective of the Study

➢ *Overall Objective*

The overall aim of the study was to investigate the models for financing renewable energy production in low-income settlements in Gauteng. The specific objectives of the study were:

- *Objective 1*

To identify and establish the existing Government policies for financing RE.

✓ *Research Questions*

- Are there existing government policies focused on RE?
- What are the categories of policies focused on RE?
- What type of financing are incorporated in the government policies on RE?

- *Objective 2*

To determine how effective Public-Private Partnership (PPP) Financing options in renewable energy are.

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✓ *Research Questions*

- How effective are PPP Financing assist in increasing the RE project visibility?
- How many successful PPP projects are for RE project Gauteng?

- *Objective 3*

To determine the role played by the DFI in the RE financing.

✓ *Research Questions*

- Why is Developed Financial Institutions (DFI) RE investment insufficient?
- What are Tax Incentives and other benefits for DFI investing in RE?

- *Objective 4*

To determine the most reliable and efficient model for financing RE in Gauteng for low-income settlements.

✓ *Research Questions.*

- Will there be a model to assist with the shortage of electricity?
- Will the suitable financing model provide relief for low-income residents of Gauteng with any form of affordable electricity?
- How will the RE be a solution to illegal connection and electricity theft?
- What impact will financing RE have on high electricity rates?

- *Objective 5*

To formulate a set of recommendations towards models for financing renewable energy production in a low-income settlement in Gauteng.

IV. RESEARCH METHODOLOGY

The research was conducted in South African, Gauteng Provinces with an investigation into the suitable models for financing renewable energy production in low-income settlements in the province. The emphasis was placed on that researcher to guard against violating participants' privacy rights by acting with sensitivity on every matter relating to data handling. Information relating to the study was held in high confidence where confidentiality disclosure was agreed upon with participants before conducting data collection. The information obtained from the participants was only used for this study (Strydom, 2011).

A. Study Location

The study was conducted in South Africa, the research took place through emails (sending questionnaires to the participants) and interviews via MS Teams due to COVID-19 restrictions on personal contacts.

B. Study Design

The study design and sampling procedure were based on guidelines set out in (Robson, 2002, p. 20-40; Babbie & Mouton, 2001, p. 15-25, Saunders et al., 2003, p. 5-14; Welman et. al., 2005, p. 35-40). Data for the research was collected using a mixed-method approach, combining secondary data from the previous studies or research paper and in-depth interviews (Appendix 1). The advantages of mixed methodological triangulation are to expand and strengthen the research conclusions and, therefore, contribute to the published literature and better contribution to the research findings (Houghton, Jubb, Kend & Ng, 2009). The study was conducted using both the quantitative and the qualitative methodology. Both research methods gathered information that was used in analysing the suitable model to use in financing renewable energy in Gauteng for low-income residents either formal or informal settlements, the participants were senior managers from the RE Experts, Energy Agencies, Banks, DFI, Government Departments on the funding, loans, bonds and grants available to the residents of Gauteng (Dlamini, 2010).

C. Source of Data

The data used in this study were sourced from both primary and secondary sources as indicated in Figure 3. The primary data was obtained through the interviews, while the secondary data was derived from the review of literature studies especially on the previous study with a similar research topic (ICAE, 2015). The primary data for the study was collected through a structured questionnaire survey distributed to stakeholders that are involved in the RE within Gauteng, the stakeholders were officials from Private, Government and Public Organisation involved in the RE projects (Clinton Aigbavboa/Energy Procedia 75, 2015).

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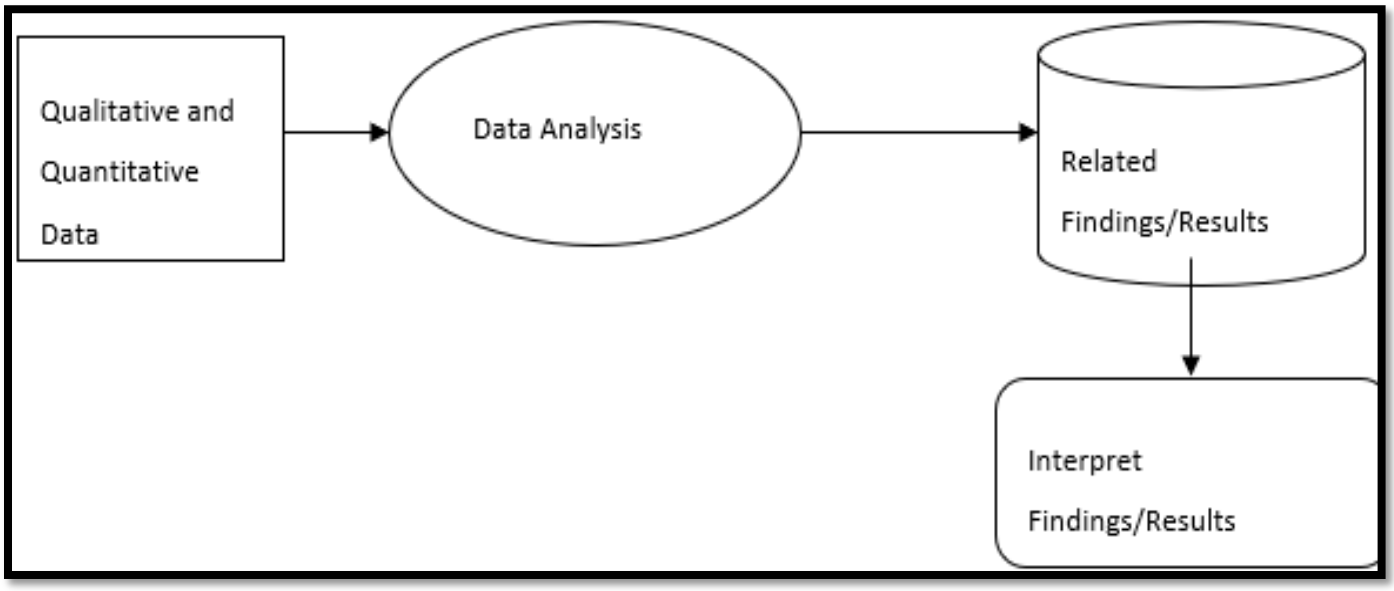

Fig 3 Mixed Methodology
Source: Author 2022

D. Data Collection and Analysis

➢ *Data Collection*

Primary data was used to gather the information and data for the study, while the method of such process was by completion of the structured interview questions that asked the senior management of the RE Experts, Energy Agencies, Banks, DFI, Government Departments. The questionnaire was divided into six sections during the interview and was the current existing model, financing options, funding's sources, partnerships between the province and private sector, available innovative ways for the low-income residents and incentives available for investing in renewable energy (Dlamini, 2010). Secondary data was sourced from the reviews and analysis of the articles, journals, annual reports, strategic plans, annual performance plans, business plans, annual financial statements, conference papers and annual budgets and other related documents like the newspapers reports and marketing pamphlets (Dlamini, 2010).

➢ *Data Analysis*

Data Analysis involves the systematic process of sorting, grouping, pairing, evaluating, and prioritising the collected data for the conclusion or making a reasonable decision concerning the research topic (Houghton, Jubb, Kend, & Ng, 2009).

➢ *Quantitative method*

The quantitative methods to analyse and elaborate results obtained from the interview were used. Statistical analysis Chi-square tests were selected as the quantitative technique serves the needs of the research in analysing statistical relating to the relationships between the variables (Oji, 2015). Chi-square was used to exam the best suitable financing model for Renewable Energy and decision trees to highlight relationships between target and input variables. The research outcome was gathered from the feedback or the survey outcome from the RE stakeholders or participants with the core variable being the suitable financial/funding models, the participants were from government, non-profit organisations, RE Experts, Financing institutions and RE producers (Oji, 2015). The hypotheses and propositions of this research were as follows:

- Hypothesis 1: Traditional financing model used more often to finance RE.
- Hypothesis 2: The total investment made by a financier indicates which methods of financing are mostly used.
- Hypothesis 3: Total number of successful RE Project financed with a certain model.

➢ *Qualitative Method*

Collected data and information were sorted, recorded, transcribed, coded, analysed, and interpreted accordingly into various interview categories (i.e., themes) in a matrix. The matrix will be interpreted in a research report (Dlamini, 2010).

V. RESEARCH RESULTS AND FINDINGS

A. Financing Energy

Energy efficiency offers a powerful and cost-effective tool for achieving a sustainable energy future. Improvements in energy efficiency can reduce the need for investment in energy infrastructure, cut energy bills, improve health, increase competitiveness, and improve consumer welfare (IEA, 2021). The DFI's normal use the local financial institution to fund the RE projects as the basis of the local content and to minimise the risk of unfinished or unsuccessful projects, as indicated in Table 2 (IEA, 2021).

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Table 2 Foreign Agencies presented in South Africa as Energy Efficiency Landscape

Foreign Agency	Total Funding	Financing Type	Local Agencies representing the Foreign Agency.
French Development Agency (AfD)	$120 Million	Credit Facility/Loan	ABSA
			Industrial Development Corporation (IDC)
			Nedbank
The Germany Development Bank (KRW)	$48 Million	Long-Term loan at the prime rate of less than 3%	Industrial Development Corporation (IDC)
International Finance Corporation (IFC)	$10 Million	Credit Facility/Loan	SASFin
Swiss State Secretariat for Economic Affairs (SECO)			
International Finance Corporation (IFC)	$50 Million	Grant/Funding (Equity)	Mercantile Bank
European Investment Bank (EIB)	$100 Million	Grant/Funding (Debt)	Investec

Source: IEA (2021).

B. RE Policies in Gauteng/South Africa

The National Development Plan (NDP) envisages that by 2030, South Africa will have an energy sector that provides reliable and efficient energy service at competitive rates; that is socially equitable through expanded access to energy at affordable tariffs, and that is environmentally sustainable through reduced emissions and pollution. In formulating its vision for the electricity sector, the NDP took as a point of departure the Integrated Resource Plan (IRP). And to be more relevant for South African policymaking in a sustainable manner, government, universities, think tanks, and research councils need to get more involved in generating energy security and energy transition relevant methodologies and data (DEA, 2019). White Paper on Energy Policy (1998) focuses on increasing access to affordable RE and reliable energy supply in assisting the poor. Then managing energy-related environmental impacts particularly focusing on poor households and securing supply through diversity (White paper, 1998). The National Energy Act outlines the importance of the diversity supply of the RE and increasing the RE production and generations. The South African RE strategy emphasises access to RE at a reasonable price for the value for money and assists in reducing pollution and promoting climate change (SEA, 2013).

C. Private, Public Partnerships in Gauteng/South Africa

Policy PPPs seek to design, advocate for, coordinate or monitor public policies of various types: sectoral, national, and/or global. Partnership structures can vary from loose and informal issue-specific networks to more formal cross-sectoral committees, task forces, or special commissions. Such PPPs can focus on the technical aspects of policies, but they are often enmeshed in politics as well. These policy networks have emerged as important transnational structures for engaging governments on global policy issues (Brinkerhoff & Brinkerhoff, 2011).

Service delivery PPPs engage non-state actors in delivering public services by separating the payment for public services from their provision. Governments (in the case of poor countries, assisted by donors) retain responsibility for financing and payment and outsource service provision to the private and/or non-profit sectors. The true partnership component of PPPs for this purpose is frequently debated since the most common mechanism connecting the partners is some form of contract, which reflects a low degree of mutuality. To the extent that the PPP operates with shared commitment and accountability, and joint planning and consultation on service mix, the relationship demonstrates more of the features (as opposed to simply the language) of partnership. Moving toward a long-term relationship based on trust and commitment shifts the contractual basis of the PPP from a traditional contract to a relational one (Brinkerhoff & Brinkerhoff, 2011). Infrastructure PPPs bring together governments and the private sector to finance, build, and operate infrastructure such as ports, highways, sewage and waste treatment facilities, telecommunications, electric power generation, and so on. Infrastructure PPPs employ a range of structures and processes, such as joint ventures with both national and multinational firms to obtain technology and capital, build-operate-transfer agreements (BOTs) of various types, and loan or trust funds (for example, housing credit funds) (Brinkerhoff & Brinkerhoff, 2011).

Capacity building PPPs may in some cases address service delivery needs, but they explicitly focus on helping to develop the skills, systems, and capabilities that allow those groups or organisations targeted for assistance to help themselves. International donors are a major source of support for such PPPs, and they can be found in a wide variety of sectors: health, education, environmental management, community development, and agriculture. Capacity building PPPs can take the form of loose knowledge networks, organisational twinning, memorandums of understanding, or formal contracts. They often have a normative orientation that highlights the autonomy and agency of assisted groups to apply their new capacities as they wish.

Ownership and empowerment are valued as enhancing independence and agency. Economic development PPPs are cross-sectoral collaborations that promote economic growth and poverty reduction. Governments and international donor partners frequently play a broker role, both in terms of finance and matching up private firms with non-governmental organisations and/or local communities. Economic

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

development PPPs can take the form of joint ventures, contracts, or memorandums of association. At the global level, PPPs aim at resource mobilisation, often for sector-specific contributions to economic development in poor countries (Brinkerhoff & Brinkerhoff, 2011). In Gauteng, only a few PPPs were implemented and are not related to RE, and the root cause may be that South Africa and the rest of the African countries have not yet invested in the RE models (SALGA, 2020).

D. Challenges with current RE Financing Model in Gauteng/South Africa

Steeply increasing electricity prices over the past 3 years. These are making alternative energy sources such as embedded photovoltaic generation and solar water heating more affordable to electricity customers. Energy efficiency is also becoming increasingly viable with reduced payback periods. The negative impact that large scale embedded renewable energy generation and energy efficiency implementation will have on municipal electricity coffers. The increased political pressure to electrify informal settlements within the municipality. Electrification of these areas has many benefits such as the reduced risk of shack fires, improved quality of life provided by electrical appliances and improved air quality through reduced use of coal and paraffin stoves in the house. However, this is a cost to the municipality which is typically cross subsidised by the commercial and high-income residential users and create the burden to those users of paying high municipal taxes and rates (SEA, 2013).

Many renewable energy technologies remain expensive, on account of higher capital costs, compared to conventional energy supplies for bulk energy supply to urban areas or major industries. Implementation of renewable energy technologies needs significant initial investment and may need support for relatively long periods before reaching profitability. There is a lack of consumer awareness of the benefits and opportunities of renewable energy. The economic and social system of energy services is based on centralised development around conventional sources of energy, specifically electricity generation, gas supplies and, to some extent, liquid fuel provision. Financial, legal, regulatory, and organisational barriers need to be overcome in order to implement renewable energy technologies and develop markets. There is a lack of non-discriminatory open access to key energy infrastructure such as the national electricity grid, certain liquid fuels and gas infrastructure (White Paper, 2003).

E. Suitable Proposed Financing Model

The extent of decommissioning of the existing coal fleet due to end-of-design life could provide space for a completely different energy mix relative to the current mix. In the period before 2030, the IRP 2019 provides for largely incremental capacity to complement the existing fixed capacity. The restructuring of the electricity sector as a whole is also underway with an R230 billion allocation over ten years, and some successful RE projects (SALGA, 2019).

VI. CONCLUSIONS AND RECOMMENDATIONS

A. Reconciliation of Research Objectives

Finance plays a critical role in the development of renewable energy in South Africa. It bridges the gap in the development of renewable energy projects (REPs). Governments' efforts towards developing RE for scaled-up renewable energy to impact the energy access challenge measurably have been inadequate. Thus, this paper focused on increasing the financial contribution of the private sector in developing RE, especially within rural communities. Models of financing RE within selected institutions are analysed, with a focus on financiers' perspectives and governments 'ultimate goal in financing RE's (White Paper, 2003).

B. Research Contribution

This research has contributed to the knowledge and awareness of the renewable energy financing model that can be used to determine the cost of producing renewable energy and the policy developers to adopt the appropriate financing model (Oji, 2016).

C. Contribution to Practice/Policy

The national policy does not have any clear regulations relating to embedded renewable energy, other than that which recognises the value of embedded generation as a demand-side measure. Thus, unless otherwise regulated by local government, customers who generate electricity on-site are not able to feed into the national electricity grid and be financially compensated for it. Municipalities are, however, investigating including embedded generation into their local policies and are running pilot projects at the moment to determine the technical constraints. This is while NERSA clarifies specifications and rules for small scale embedded renewable energy. The funding mechanisms for electrification and free basic have not changed which is a great drain on resources for municipalities (SEA, 2013). In response to RE challenges, the goal of this research is two-fold: first, to explore new models for renewable energy development that create a greater role for public and community ownership, and second, to consider the implications these business models have for increasing renewable energy deployment in South Africa (IRP, 2019).

D. Limitations and Recommendations for Future Research

There are only a few successful RE projects in Gauteng and South African resulting in only a few research participants. The results of the research will have an impact on future studies and may affect the RE stakeholder's views when it comes to the traditional way that South Africa has been delaying in promoting RE especially in the overpopulated provinces like Gauteng. In this research, the purpose was to investigate the suitable financing model for renewable energy for the low-income dwellers or informal settlements that are not receiving electricity from Eskom to focus on solar panels and other renewable energy sources that will be cheaper to generate.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

E. Conclusion

Firstly, a policy and regulatory gap analysis is needed to see what policies and regulations are missing in South Africa. This should be done against the policies and regulations that have enabled the rollout of each financing model in our case studies. Initial findings show that, for all models, some form of electricity sector/RE. Secondly, questions remain around the extent to which the domestic and international financial sectors will be willing to provide finance for each of these financing models, and what form of government support (policy, public finance, etc.) is necessary to help mobilise the necessary finance. Lastly, is to perform a deep-dive assessment of the roadblocks to financing renewable projects for each model and suggest potential solutions.

ACKNOWLEDGEMENTS

First, I would like to give thanks to God, for giving me wisdom and bliss. I know that without His presence I could not have completed my research. I would love to express my deepest gratitude to my supervisor, Dr Dlamini, for his support, dedication, understanding and continuous guidance throughout this research. I wish to thank my wife Boikhutso for her support during this programme through various sacrifices. Special mention goes to my son Vinay, daughters Wisani and Rhulani for encouraging and supporting me to go through with the research. My sincere appreciation also goes to my siblings, Godfrey, Joyce and Fikile, my granny Fanisa Maluleke for believing in me in every step of my life.

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APPENDICES

APPENDIX A: RESEARCH QUESTIONNAIRES FOR RE FINANCING

➢ *Purpose of the questionnaires*

The research focuses on the financing model for renewable energy as a critique for the widespread dissemination of RE. The questionnaire aims to obtain information on the preferences of the RE-funding option in South Africa, Gauteng. The questionnaires aim to gather data on which financing model and mechanism through which the RE will be financed. The information is necessary to develop theories in which finance would play a great role in increasing the adoption of RE projects especially in low-income communities (Oji, 2015).

➢ *Confidentiality*

All responses will be treated confidentially and only the aggregation of the results would be presented at the end of the research. Respondents would remain anonymous as a means to protect their identities. The participant information will only be used for research purposes and the studies and will not be shared with any person (Oji, 2015).

➢ *Participants Information:*

1. Please specify your age group

Under 30 years ☐

31-40 years ☐

41-50 years ☐

51 and above ☐

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

2. Please specify your gender:

Male ☐

Female ☐

3. Which sector does your entity fall:

Non-Profit Organisation. ☐

Private Company ☐

Public Company ☐

Government Department/Entity ☐

State-Owned Entities ☐

Independent Experts ☐

Other (please specify) ☐

4. What educational background do you have?

Economics ☐

Business Administration ☐

Engineering ☐

Multidisciplinary ☐

Finance ☐

Legal ☐

Science & Technology ☐

Other (please specify) ☐

5. How many years of experience/involvement in the RE development sector do you have?

No Experience ☐

Experience of 5-10 years ☐

Experience of lesser than 5 years ☐

Experience of more than 10 years ☐

Objective 1: Policies Issues

Q1. Does the renewable energy policy influence the choice of suitable financing model in South Africa/Gauteng?

Yes ☐

No ☐

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Q2. What are the policy challenges in implementing renewable energy in South Africa?

Insufficient Funding ☐

Lack of Policy on RE ☐

Investors not interested in the RE ☐

Limited innovation ☐

Q3. What are RE policies best describe an increase in the renewable energy financing model?

Feed-in tariffs ☐

Tax Reduction ☐

Interest-Free Grant/Funding ☐

Rebates for RE Projects ☐

Public-Private Partnership ☐

RE Production Credits ☐

Q4. Does the deployment of RE limit the potential for illegal electricity connection?

Yes ☐

No ☐

Q5. Which RE solution will be suitable for low-income residents of Gauteng?

Biomass ☐

Hydropower ☐

Geothermal ☐

Wind ☐

Solar ☐

Objective 2: Involvement of Public-Private Partnership.

Q1. What are the cost benefits of financing renewable energy projects?

Q2. Do you think there are available opportunities in financing the RE in the form of Social Investment?

Yes ☐

No ☐

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

Q3. Do you think the Private Public Partnership will be suitable for financing Renewable Energy?

Yes ☐

No ☐

Objective 3: The involvement of the Private Sector (DFI/FDI/Banks)

Q1. Are the Foreign Direct Investment interested or are involved in the RE especially in South Africa?

Yes ☐

No ☐

Q2. How important is the role of the Private Sector and Foreign Investors in financing RE?

Not important ☐

Moderately important ☐

Indifferent ☐

Highly important ☐

Objective 4: Suitable Financing Model for Gauteng in South Africa.

Q1. What is the best source of capital for financing the RE Projects in Gauteng?

Government grants ☐

Foreign donations ☐

Private capital ☐

Debts and loans ☐

Public-Private Partnership ☐

Q2. What method is mostly used to finance RE projects?

Project finance ☐

Mezzanine finance ☐

Senior debts ☐

Equity ☐

Consumer credit ☐

Dealer credit ☐

Fee-for-Service ☐

Other (please specify) ☐

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

Q3. What do you think motivates the financiers to choose the above-selected method?

Increase in profits ☐

Reduce risks ☐

Faster rate of RE adoption ☐

Investment is easy to monitor ☐

Potential to increase energy access ☐

Tax reduction ☐

Q4. What is the most important barrier to increasing the financing operation of the RE projects?

High capital cost ☐

High-interest rates ☐

High credit repayments rate ☐

Low access to capital ☐

Lack of awareness and campaign on RE incentives ☐

Other (please specify) ☐

Q6. How do you measure value obtained from the developing RE projects in communities?

In financial terms ☐

In economic terms ☐

Both Financial and Economic terms ☐

Other (please specify) ☐

Q7. How would you rate the impact of RE project financing on communities?

Insignificant ☐

Below average ☐

Average ☐

Above average ☐

Q8. What is the most common change observed in the communities or townships due to the availability of RE?

Higher Societal status ☐

Better living standards ☐

More disposable income ☐

Other (please specify) ☐

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug358

APPENDIX B: REGISTERED CURRENT PUBLIC-PRIVATE PARTNERSHIP IN GAUTENG

Project no.	Municipality	Project	Status
M074	Drakenstein	LM Waste to Energy	Procurement
M100	Midvaal	LM Midvaal Electricity Distribution	Feasibility Study
TASM 127	Emfuleni	LM Emfuleni Waste-to-energy	Project Inception

Source: SALGA 2020

APPENDIX C: SUCCESSFUL RE PROJECTS IN GAUTENG

Project Name	Project Funders	Project Type	Funding Model	Project Location
Rosslyn Brewery Fuel Switch Project	South African Brewery	Fuel switching from coal to natural gas.	Equity (Investment)	Rosslyn
EnviroServ Chloorkop landfill gas recovery	EnviroServ Waste Management (Pty) Ltd	Energy Generation	Government Grant	Johannesburg
Transalloys Maganese alloy smelter energy efficiency.	EcoSecurities South Africa	Energy Efficiency	Bank Loan (Energy Credit)	Witbank
Alrode-Biodiesel	Exclusive Access Trading (Pty) Ltd	Renewable Energy	Equity (Investment)	Alrode
Tshwane Lilanda Methane gas project	City of Tshwane Municipality	Methane Flaring and Electricity Generations	Municipality Infrastructure Grant	Tshwane.
Molten slag and metal project	Ekurhuleni Municipality	Energy Efficiency	Municipality Infrastructure Grant	Germiston
Installation of solar heating systems in low-cost housing in Gauteng	Provincial Department of Housing.	Energy Efficiency	Municipality Infrastructure Grant	Gauteng Province.
Calgro M3 Green Project	City of Johannesburg	Renewable Energy	Municipality Infrastructure Grant	Johannesburg
SASSA Low-Pressure Solar Water Heater	International Carbon	Renewable Energy	Direct Foreign Investment	Gauteng Province.
Solar Water Heating Project	Unlimited Energy Resources (Pty) Ltd	Renewable Energy	Equity (Investment)	Gauteng Province.

Source: SALGA (2020).