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Can Renewable Energy Offset the Economic Costs of Loadshedding in the Eastern Cape Province of South Africa? A Social Accounting Matrix Analysis

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ABSTRACT

Reliable electricity supply is a key driver of economic growth, employment, and social welfare, yet persistent load shedding continues to constrain South Africa's development, particularly in the Eastern Cape. The province's high unemployment, low investment, and reliance on energy-intensive sectors make it especially vulnerable to electricity shortages. Renewable energy investments through the Independent Power Producers Procurement Programme (IPPPP) offer a pathway to stabilize supply, stimulate economic activity, and promote sustainable growth. Using a Social Accounting Matrix (SAM)-based multiplier model, this study quantifies the economy-wide effects of two scenarios: the contraction caused by load shedding and the expansionary fiscal injection of R21.9 billion into renewable energy. Our analysis captures direct, indirect, and induced impacts across sectors, providing evidence on how renewable energy can not only offset losses but also generate broader economic and employment benefits in the Eastern Cape.

Keywords: Loadshedding, Power Outages, Renewable Energy, Social Accounting Matrix, Eastern Cape, South Africa
JEL Classifications: C67; E62; Q42; Q43

1. INTRODUCTION

Loadshedding has become one of the most pressing challenges facing South Africa's energy sector and is widely viewed as a major structural barrier to achieving key sustainable development goals such as "*ensuring access to affordable, reliable, sustainable and modern energy for all*" (SDG 7) and "*promoting sustained and inclusive economic growth*" (SDG 8). First introduced in 2007 as a last resort to prevent a collapse of the national grid (Marope and Phiri, 2024), loadshedding has unfolded over three broad periods: 2007–2009, 2013–2015, and the most severe phase from 2018 to 2023, when higher stages such as 6, 7 and 8 were implemented for the first time with over 1900 h of power cuts (Walsh et al., 2021; Mabunda et al., 2023).

The roots of loadshedding trace back to sustained low electricity prices and the country's heavy dependence on coal-fired generation. Historically, electricity remained cheap because ESKOM was financed through low-cost public capital during and after the apartheid era. After 1994, this approach continued, and low tariffs were used to support industrial activity and expand access for low-income households. However, these goals placed long-term pressure on ageing coal plants, which were neither maintained nor replaced at the pace required due to limited revenue from low tariffs (Naidoo, 2023). As a result, breakdowns of generation units became more frequent.

Although electricity prices have risen sharply over time, the deep reliance on coal remains the core driver of ongoing loadshedding. South Africa is still one of the world's largest coal users and, in turn, one of the highest carbon emitters (Nyoni and Phiri, 2022). This dual challenge of persistent electricity shortages and rising emissions has placed renewable energy at the centre of the national conversation. Renewables are seen as a key pathway to address loadshedding and reduce environmental harm (Phiri and Nyoni, 2023). Beyond improving supply stability, renewable energy supports progress on other SDGs, including "*good health and well-being*" (SDG 3) and "*climate action*" (SDG 13).

South Africa's transition towards renewable energy has largely been channelled through the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), launched in 2011. The programme is widely recognised as one of the fastest-growing and most successful renewable energy procurement systems globally (Nyoni and Phiri, 2020). Although designed at the national level, REIPPPP projects have clear and uneven provincial impacts.

The Eastern Cape is one of the provinces most shaped by REIPPPP activity. The province has rich natural resources, especially strong wind potential due to its long coastline. Wind power makes up most of its renewable energy capacity, and 137 projects have been implemented to date. Yet, the province remains one of South Africa's poorest regions and contributes the least to national GDP. Its economic structure differs from the national profile because it lacks a major mining sector and relies heavily on services, especially the public sector (Dyasi and Phiri, 2019). In such a context, loadshedding poses an even greater threat to welfare due to already high unemployment, a weak economic base, and pressing social challenges (Mukumba and Chivanga, 2023).

Our study applies a SAM-based framework to examine whether renewable investments under REIPPPP can help cushion the economic costs of loadshedding in the Eastern Cape. We simulate two scenarios. Firstly, we estimate the economy-wide impact of loadshedding by introducing a shock that reflects the loss of electricity supply. These figures are used because they capture the scale and frequency of recent loadshedding episodes. Secondly, we simulate the effect of a R21.9 billion fiscal injection into renewable energy infrastructure in the province. Finally, we compare both results to determine the net economy-wide benefit of renewable investment relative to the costs of loadshedding. In doing so, the study answers three empirical questions:

(i) What are the economy-wide effects of loadshedding in the Eastern Cape?
(ii) What are the economy-wide effects of REIPPPP investments in the province?
(iii) Can the REIPPPP investment offset the negative effects of loadshedding on economic activity?

The rest of the paper is structured as follow. The next section discusses the literature review. Section 3 outlines our empirical framework. Section 4 presents our empirical analysis. Section 5 concludes the study.

2. LITERATURE REVIEW

Reliable electricity supply is considered as one of the main drivers of economic growth and development, and improved social welfare (Guo et al, 2023). As such, several studies have attempted to document the economic impact of electricity outages on households, businesses and the economy. In addition, previous studies have applied different economic models to measure the direct and indirect impact of electricity outages. As a result, the analysis of the empirical literature in this paper is divided into two parts. The first part of the literature focuses on the impact of electricity outages on households, businesses and economy while the second part deals with various economic models used by previous studies to assess the direct and indirect impact of power outages. However, it is important to note that the analysis of the empirical literature in this paper pays specific attention to studies in Africa. This is because most Africa countries tend to experience chronic electricity outages as opposed to sporadic outages as described by Naidoo (2023).

Regarding the previous studies on the impact of electricity outages on the households, businesses and economy, these studies can be categorised into three groups. The first group of studies are those that focused on the impact of electricity outages on households across different countries (Carlsson et al., 2021; Hensher et al., 2014; Kim et al., 2015; Küfeoğlu and Lehtonen; 2015; Lehmann et al., 2022; Ozbafli and Jenkins, 2015; Vennemo et al., 2022; Bekun et al., 2025). These group of studies estimated the cost of electricity outages by analysing households' willingness to pay (WTP) to avoid electricity outages and cost of alternative power source during outages. An example of such study in Africa can be found in the work of Meles (2020) who analysed the impact of electricity outages in Ethiopia and found that while the average monthly defensive expenditure varies with monthly hours of electricity outages, households were willing to pay between US$1.3-1.5/month for improved electricity supply, on top of their regular monthly electricity bill. Another study in Ethiopia by Aweke and Navrud (2022) found that households were willing to pay about US$18/year or 1% of their annual income. In Ghana, Amoaha et al. (2019) found that households were willing to pay US$17/month or equivalent to 7% of their income, for reliable electricity supply. Similar study in South Africa by Nkosi and Dikgang (2018) found that households' average WTP ranges from US$4.07-6.36, depending on the period and season.

Another aspect explored by previous studies regarding the impact of electricity outages is on households' welfare. This is because households are considered the end-users of electricity, and power outages negatively affect their welfare. For instance, Nduhuura et al. (2021) examined the impact of electricity outages among urban households in Ghana and found that households' security, access to food, and social services, damages to their appliance were among the impacts of electricity outages. Likewise, Mabhanda and Kurebwa (2015) in Zimbabwe found that electricity outages cause damages to households' appliance and reduce their living standards. Also, Ugembe et al. (2023) considered electricity outages in Mozambique and found that it contributes negatively to generation of sustainable livelihood.

The second group of studies are those that considered the impact of electricity outages on businesses. Examples of these studies can be found in the works of Alam (2013), Allcott et al. (2016), Chen et al. (2022), Chovančíková and Hoterová (2021), Elliott et al. (2021), Fakih et al. (2020), Guo et al. (2023), Lebepe and Mathaba (2024), and Luqman et al (2021). Similar studies in Africa focused on the impact of electricity outages on small businesses. For instance, study by Avordeh et al. (2024) provides a systematic review of literature in Sub-Saharan Africa (SSA) and found that electricity outages lead to reduced productivity, operational inefficiencies, increased cost of production and supply chain disruptions among small businesses. Cole et al. (2018) used firm-level data for 14 SSA countries and found that unreliable electricity supply negatively affects firms' sales with a stronger effect on those without a generator. Also, a study by Osei-Gyebi and Dramani (2023) for 28 SSA countries found that increased outage frequency and its duration reduce the yearly sales by firms with small businesses experiencing more losses than large firms. Likewise, Mensah (2016) considered 15 SSA countries and revealed evidence of significant negative impact of electricity outages on firm productivity, size and labour employment. Focusing on 10 SSA countries, Abotsi (2016) found that monthly power outages reduce production efficiency of African firms.

In Nigeria, studies by Adanlawo and Vezi-Magigaba (2021), Moyo (2012) and Ogunlami et al. (2021), on small businesses found adverse effect of electricity outages on the performance and productivity of these firms. Related study in Senegal by Cissokho (2020) found that power outages negatively affect small business productivity. In Ghana, Sosi and Atitianti (2021) reported negative effect on firms' sales and productivity, which is higher among manufacturing firms compared to firms operating in the service sector. Abdisa (2018) focused on firms in Ethiopia and found that power outages negatively affect firm's productivity and increases the cost of production. Also, Maende and Alwange (2020) reported negative and significant relationship between power outages and firms' profitability in Kenya. Similar study in South Africa by Mabunda et al (2023) on small businesses in Collins Chabane Local Municipality found that power outages costed on average 61% of their total revenue and 59% of these businesses laid off their employees to cover costs.

The third group of studies are those that considered the impact of electricity outages from a macroeconomic perspective by focusing on its effects in the economy (Chen et al., 2023; Linares and Rey, 2013; Wang et al., 2024; Wu et al., 2018). Specifically, a study by the South African Reserve Bank (SARB, 2023) estimated that electricity outages reduced the country's economic growth by between -0.7% and -3.2% in 2022. A related study by Erero (2023) estimated that electricity outages would reduce South African GDP by 2.3% in 2023. Also, study by Walsh et al. (2020) estimated that the cost of loadshedding in kilowatt per hour (kWh) has increased from R7.61/kWh during 2007-2088 to R9.53/kWh during 2018-2019. The study further revealed that loadshedding reduced the South African GDP by about R34.5 billion over the period 2007-2019.

Besides the impact of electricity outages on households, businesses and the economy, another aspect of the literature considered in this paper is the various economic models used to quantify the impact. Due to difficulties in estimating the impact of electricity outages, previous studies have applied various economic models. However, the analysis of literature shows that these economic models can be conveniently categorised into two groups (namely backward-looking and forward-looking models). On the one hand, backward-looking models rely on historical data pertaining to specific power outage event(s) or series of power outages events and survey of consumer willingness to pay to avoid or accept power outages (Linares and Rey, 2013; Walsh et al., 2020). The commonly used approaches by studies following the backward-looking models include case studies, contingent valuation (survey) method and production function/econometric models. Examples of studies that followed any of these approaches can be found in the works of Adanlawo and Vezi-Magigaba, (2021), Amoah et al. (2019), Chen et al. (2023), Cole at al. (2018), Elliott et al. (2021), Vennemo et al. (2022). However, a major weakness of these approaches is that they are based on partial equilibrium framework (Wang et al., 2024).

On the other hand, the forward-looking models are based on simulation of the potential impact of electricity outages on the economic system (Chen et al., 2022). Importantly, forward-looking models are particularly useful in analysing the economy-wide impact of shocks due to power outages. In other words, the forward-looking models are based on general equilibrium frameworks unlike the backward-looking models. The two commonly used approaches in the literature for forward-looking models are the Input-output (IO) model and Compatible General Equilibrium (GCE) model (Chen et al., 2022; Erero, 2023; Shuaia et al 2018; Walsh et al., 2020; Wang et al., 2024; Wu et al., 2018).

Overall, the analysis of previous study provided evidence on the impact of electricity outages on households, businesses and the economy using different economic models. Our study is similar to studies that considered the macroeconomic impact of electricity outages using forward-looking models. However, in the context of South Africa and Eastern Cape Province in particular, there are gaps in the literature. Specifically, there is no existing literature on the impact of electricity outages on provincial economy in South Africa.

3. METHODOLOGY

This study applies a Social Accounting Matrix (SAM)–based Leontief multiplier model to examine how loadshedding and renewable-energy investment affect the Eastern Cape economy. The SAM captures all income flows within the provincial economy and allows us to trace how a shock in one part of the system spreads to all other sectors (Pyatt and Round, 1985; Breisinger et al., 2009).

3.1. SAM Framework

In the SAM, the economy consists of n sectors. Total output and total input are defined as:

$$X_i = \sum_{j=1}^{n} Z_{ij} + f_i \tag{1}$$

$$X_j = \sum_{i=1}^{n} Z_{ij} + u_j \tag{2}$$

Where X_i is total output in sector i, X_j is total output in sector j, Z_{ij} is the intermediate input from sector i to sector j, f_i is final demand and u_j is the primary input.

3.2. SAM Demand-driven Model

The analysis uses the standard Leontief demand-driven multiplier model, which estimates the effect of a change in final demand on sectoral output. The model is expressed as:

$$X = (I-A)^{-1} F \text{ and } X = AX + F \quad (3)$$

Where (I-A) is the Leontief inverse, I is an identity matrix, F is the final-demand vector and A is a technical coefficient matrix defined as:

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix} \quad (4)$$

Each coefficient a_{ij} is calculated as:

$$a_{ij} = \frac{Z_{ij}}{X_j} \quad (5)$$

indicating the input from sector i required to produce one unit of output in sector j.

3.3. SAM Supply-driven Model

To capture how changes in sectoral supply influence the wider economy, the Ghosh supply-driven model is also applied:

$$c_{ij} = \frac{Z_{ij}}{X_j} \quad (6)$$

And is expressed as:

$$X' = X'C + u' \quad (7)$$

where C is the output-coefficient matrix defined as:

$$C = \begin{pmatrix} c_{11} & \cdots & c_{1n} \\ \vdots & \ddots & \vdots \\ c_{n1} & \cdots & c_{nn} \end{pmatrix} \quad (8)$$

For the renewable-energy sector, the technical coefficient is:

$$R_e = \frac{Z_{ej}}{X_e} \quad (9)$$

3.4. Coefficient Stability

The use of linear SAM multipliers depends on the stability of input or output coefficients. Following Chen and Rose (1990), stability is tested as:

$$\Delta = (a_{ij} - a^*_{ij}) = \left(\frac{Z_{ij}}{X_j} - \frac{Z^*_{ij}}{X^*_j} \right) \quad (10)$$

Stable coefficients justify the use of a linear SAM multiplier framework.

3.5. Model Simulations

Two simulations were performed to assess the province's economic response to electricity-supply shocks and renewable-energy expansion.

1. Loadshedding shock: A negative shock of –2.841% was applied to provincial GDP, based on recent macroeconomic estimates of the cost of loadshedding in South Africa. This shock captures the contractionary effect of supply disruptions on production, employment and investment.
2. Renewable-energy investment shock: A fiscal injection of R21.9 billion into renewable-energy activities was introduced to simulate the effect of Independent Power Producer projects on output, employment and investment. The investment was incorporated as an increase in final demand for the renewable-energy sector.

Changes in GDP, employment, investment and sectoral output were then traced through the SAM multipliers to estimate the economy-wide effects of each scenario.

3.6. Inter-industry Linkages

Backward and forward linkages were calculated to assess how strongly renewable energy interacts with other sectors. The Backward linkages are computed as:

$$BL_j^c = \sum_{i=1}^{n} \frac{x_{ij}}{x_j} = \sum_{i=1}^{n} b_{ij} \quad (11)$$

Whilst forward linkages as:

$$FL_i^c = \sum_{j=1}^{n} \frac{x_{ij}}{x_i} = \sum_{j=1}^{n} a_{ij} \quad (12)$$

These linkages capture both the dependence of renewable energy on upstream sectors and its role as an input to downstream activities.

4. RESULTS AND DISCUSSIONS

4.1. Impact of Loadshedding on the Eastern Cape Economy

Table 1 presents the simulated effects of the –2.841% GDP shock caused by loadshedding. The results show that persistent electricity shortages have severe macroeconomic consequences for the Eastern Cape province. The SAM estimates indicate that provincial GDP contracted by 2.84% due to reduced production across key sectors. This contraction reflects the broader pattern observed in national studies where loadshedding sharply reduced South Africa's economic growth (SARB, 2023; Erero, 2023) and raised economy-wide costs (Walsh et al., 2020).

Employment in the province declined by 2.11%, illustrating how electricity shortages disrupt labour-intensive activities and force firms to scale down operations. The number of unemployed people increased by 1.9%, raising the official unemployment rate by 0.7%. These results reinforce earlier findings from Sub-Saharan Africa showing that power outages significantly reduce firm productivity, labour demand and employment opportunities (Mensah, 2016; Osei-Gyebi and Dramani, 2023; Mabunda et al., 2023).

Investment levels in the Eastern Cape also fell by 1.43%. This decline reflects the rising cost of doing business in the presence of unreliable electricity supply. Previous studies across Africa show that electricity outages increase operating costs through additional spending on generators, backup systems, storage, and labour adjustments (Avordeh et al., 2024; Moyo, 2012; Cissokho, 2020). The EC mirrors these patterns, where firms incur higher costs to safeguard perishable goods, maintain cold-chain systems, power irrigation equipment and protect machinery from unplanned shutdowns.

At the sector level, the results show large declines in output among energy-intensive industries. Manufacturing contracted by 5.43%, followed by wholesale and retail trade (–4.05%), agriculture (–3.04%) and mining (–2.90%). These findings are consistent with African and international evidence showing that electricity shortages have disproportionate impacts on sectors dependent on continuous power supply (Cole et al., 2018; Abotsi, 2016; Wu et al., 2018). In the Eastern Cape, these declines are concerning given the province's already fragile industrial base and heavy reliance on the tertiary sector for economic activity (Dyasi and Phiri, 2019).

Overall, the results confirm that chronic power shortages undermine industrialisation, investment, job creation and economic stability in the Eastern Cape. This aligns with the broader literature showing that Africa's chronic electricity deficits weaken household welfare, business performance and macroeconomic growth (Guo et al., 2023; Amoah et al., 2019; Linares and Rey, 2013). In a province already facing the highest unemployment rate in the country, stabilising electricity supply remains essential for restoring economic activity, supporting firms and enabling long-term development.

4.2. Impact of Renewable-energy Investment on the Eastern Cape Economy

The injection of R29.9 billion into renewable-energy infrastructure through the Independent Power Producers Procurement Programme (IPPPP) represents a substantial fiscal stimulus for the Eastern Cape economy. This investment—equivalent to roughly 6.9% of provincial GDP—strengthens the province's energy capacity while stimulating broad-based economic activity. The results from the SAM simulation reported in Table 2 show that renewable-energy investment has strong positive spillovers across output, employment, and fixed capital formation, demonstrating the potential of clean-energy expansion to support inclusive and sustainable growth.

The model results indicate that total production output increases by 4.59% following the investment shock. This expansion reflects the high backward linkages of the energy sector, which stimulate demand for construction materials, engineering services, transport, manufacturing inputs and other upstream industries. These findings are consistent with international evidence that renewable-energy projects have strong multiplier effects due to their capital-intensive

Table 1: Impact of loadshedding on the Eastern Cape province economy

Description of variables	Unit	Baseline (2022)	Simulation results (% change)
Gross domestic Product	R million (Constant Prices)	R 365,916	−2.841
Turnover (Total production output)	R million (Constant Prices)	R 960,097	−3.012
Total number of people employed (formal and informal)	Number (1000)	1,373	−2.109
Total number of people unemployed	Number (1000)	1,082	1.896
Unemployment rate (Official definition)	Percentage	44%	0.701
Gross Domestic Fixed Investment	R million (Constant Prices)	R 45,659	−1.427
Net taxes			
Turnover decline in the top energy-intensive sectors			
Total production output in the manufacturing sector	R million (Constant Prices)	R 220,503	−5.427
Total production output in the mining sector	R million (Constant Prices)	R 5,706	−2.903
Total production output in the agriculture sector	R million (Constant Prices)	R 27,923	−3.039
Total production output in the wholesale and retail trade sector	R million (Constant Prices)	R 151,678	−4.047

Source: Own calculations derived from the SAM-based Leontief model

Table 2: Impact of REIPPPP investment in renewable energy

Description of variables	Unit	Baseline (2022)	Simulation results (% change)
Gross domestic Product	R million (Constant Prices)	R 365,916	5.981
Turnover (Total production output)	R million (Constant Prices)	R 960,097	7.604
Total number of people employed (formal and informal)	Number (1000)	1,373	8.172
Total number of people unemployed	Number (1000)	1,082	-4.436
Unemployment rate (Official definition)	Percentage	44%	-1.926
Gross Domestic Fixed Investment	R million (Constant Prices)	R 45,659	3.617
Net taxes			
Turnover decline in the top energy-intensive sectors			
Total production output in the manufacturing sector	R million (Constant Prices)	R 220,503	8.712
Total production output in the mining sector	R million (Constant Prices)	R 5,706	3.134
Total production output in the agriculture sector	R million (Constant Prices)	R 27,923	5.403
Total production output in the wholesale and retail trade sector	R million (Constant Prices)	R 151,678	6.104

Source: Own calculations derived from the SAM-based Leontief model nature and broad supply-chain requirements (Shuaia et al., 2018; Chen et al., 2022). In the African context, investment in electricity infrastructure has also been shown to boost economic activity by reducing operational inefficiencies and lowering production costs for firms (Cole et al., 2018; Abotsi, 2016).

Provincial GDP grows by 5.98% under the renewable-energy investment scenario. This sizeable increase aligns with the literature emphasising that energy reliability is a prerequisite for sustained economic expansion (Guo et al., 2023; Wang et al., 2024). By adding new generation capacity, the investment alleviates energy constraints, supports continuous industrial operations, and enhances productivity across multiple sectors.

Employment effects are particularly noteworthy. The results show a 6.06% increase in total employment, driven by labour-intensive construction phases, operational jobs in renewable-energy facilities, and induced employment through increased household income and spending. These findings mirror evidence from Sub-Saharan Africa, where infrastructure and energy-sector investments have been found to support job creation and improve labour-market outcomes (Mensah, 2016; Mabunda et al., 2023). Given that the Eastern Cape has the highest unemployment rate in South Africa, the employment effect of renewable-energy investment is especially significant for provincial development.

Gross fixed capital formation rises by 2.19%, illustrating how renewable-energy projects stimulate new investment and potentially crowd-in further private capital. This aligns with broader research showing that stable electricity supply reduces business uncertainty, lowers production disruptions and strengthens investor confidence (Cissokho, 2020; Osei-Gyebi and Dramani, 2023).

Sector-level effects show gains across various industries as improved electricity availability increases production capacity and reduces reliance on costly backup systems. Notably, sectors sectors previously shown to be vulnerable to electricity shortages such as manufacturing, agriculture, mining and trade benefit from enhanced operational continuity (Wu et al., 2018; Avordeh et al., 2024). These sector-specific improvements reinforce the view that energy infrastructure is foundational for industrialisation and regional economic diversification.

Overall, the findings demonstrate that large-scale renewable-energy investment is an effective mechanism for stimulating economic activity, strengthening energy security, and improving labour-market outcomes in the Eastern Cape. Beyond contributing to environmental sustainability, such investments support long-term economic resilience and lay the foundation for a more reliable and inclusive provincial growth path.

4.3. Net Economy-wide Effects: Can Renewable Energy Offset the Impact of Loadshedding?

The final stage of the analysis compares the economic losses caused by loadshedding with the gains generated by the R21.9 billion renewable-energy investment. The net-effects results provide a clear answer to the central question of the study: can renewable-energy expansion counter the economic damage caused by persistent electricity shortages in the Eastern Cape?

The results in Table 3 show that renewable-energy investment more than offsets the negative effects of loadshedding across all major macroeconomic indicators. The combined outcome is strongly positive, indicating that renewable-energy development is not only a recovery tool but also a catalyst for long-term provincial growth.

Provincial GDP records a net increase of 3.14%. This means the renewable-energy investment fully reverses the 2.84% GDP loss from loadshedding and pushes the economy above its baseline level. This finding is consistent with wider literature showing that forward-looking, energy-sector investments can lift economic output by easing supply constraints and reducing production downtime (Chen et al., 2022; Wang et al., 2024). It also supports evidence from South Africa, where reliable electricity has been identified as a key driver of national economic stability (SARB, 2023; Erero, 2023).

Total production output increases by 4.59% on net, reflecting stronger industrial activity once reliable electricity supply is restored. Companies are able to operate longer hours, avoid disruptions, and reduce reliance on costly backup systems. These patterns are also observed in studies across Sub-Saharan Africa where poor electricity supply has been linked to reduced firm productivity and higher operating costs (Cole et al., 2018; Avordeh et al., 2024).

Employment shows the most striking result, with a net gain of 6.06%. In a province with the highest unemployment rate in the country, these jobs represent a meaningful improvement in livelihoods. The fall in unemployment by 1.23% indicates that renewable-energy expansion directly supports labour-intensive construction work and indirectly boosts employment through stronger output in manufacturing, agriculture, trade and related services. These findings echo evidence from infrastructure investment studies in Ghana, Ethiopia and Kenya where improved electricity availability reduced operational inefficiencies and supported employment growth (Aweke and Navrud, 2022; Abdisa, 2018; Maende and Alwange, 2020).

Gross fixed investment also rises on net by 2.19%, suggesting that renewable-energy projects crowd in further economic activity and stimulate confidence among producers. This aligns with the notion that stable electricity supply is essential for attracting and sustaining investment flows (Cissokho, 2020).

At the sector level, the results show that renewable energy is able to reverse the sharp contractions experienced in manufacturing, agriculture, mining and wholesale and retail trade due to loadshedding. Manufacturing, which experienced the deepest decline under loadshedding, achieves a net increase of 3.29%, illustrating how strongly it responds to improved energy security. Similar positive net effects are observed in agriculture (2.36%), trade (2.06%) and mining (0.23%). These findings reinforce earlier evidence that energy-intensive sectors are highly sensitive to electricity disruptions (Mabunda et al., 2023; Wu et al., 2018) and benefit immediately when supply improves.

Table 3: Net effect of REIPPPP investment in relation to loadshedding

Description of variables	Unit	Baseline (2022)	Simulation loadshedding (%)	Simulation IPPPP (%)	Net effect (%)
Gross domestic Product	R million (Constant Prices)	R 365,916	−2.841	5.981	3.140
Turnover (Total production output)	R million (Constant Prices)	R 960,097	−3.012	7.604	4.592
Total number of people employed (formal and informal)	Number (1000)	1,373	−2.109	8.172	6.063
Total number of people unemployed	Number (1000)	1,082	1.896	−4.436	−2540
Unemployment rate (Official definition)	Percentage	44%	0.701	−1.926	−1.225
Gross Domestic Fixed Investment	R million (Constant Prices)	R45,659	−1.427	3.617	2.190
Turnover decline in the top energy-intensive sectors					
Total production output in the manufacturing sector	R million (Constant Prices)	R 220,503	−5.427	8.712	3.285
Total production output in the mining sector	R million (Constant Prices)	R 5,706	−2.903	3.134	0.231
Total production output in the agriculture sector	R million (Constant Prices)	R 27,923	−3.039	5.403	2.364
Total production output in the wholesale and retail trade sector	R million (Constant Prices)	R 151,678	−4.047	6.104	2.057

Source: own calculations derived from the SAM-based Leontief model

Overall, the combined results show that renewable-energy investment not only mitigates the economic damage caused by loadshedding but also delivers clear additional gains to the provincial economy. These findings underline the importance of scaling up clean-energy infrastructure as part of a broader strategy to stabilise South Africa's electricity system, support inclusive growth and reduce vulnerability to future power shortages. The Eastern Cape, with its strong renewable-energy potential, stands to benefit significantly from sustained investment in this sector.

5. CONCLUSION

The study uses a SAM framework to examine whether renewable energy investment can offset the economic costs of loadshedding in the Eastern cape province of South Africa. The results from this study show that the economic implications of expanding renewable energy in the Eastern Cape are neither automatic nor uniform. The final outcomes depend strongly on the scale of investment, the structure of the provincial economy, and the transmission channels through which energy shocks spread across sectors. While the overall findings highlight the clear potential of renewable energy to reverse the losses caused by persistent loadshedding, the magnitude of these gains varies across sectors and macroeconomic indicators.

The most positive results emerge when all direct and indirect effects of renewable-energy investment are considered. Under this broader scope, the R29.9 billion injection generates a strong expansionary effect across the provincial economy such as raising GDP, employment, production output and fixed investment. These gains arise mainly through higher demand for construction, manufacturing, transport, professional services and other upstream activities. However, similar to experiences reported in studies for other African regions, the extent of these benefits depends on how effectively renewable projects link with the rest of the economy. Provinces with shallower industrial bases or weaker supply chains may experience more moderate gains as leakages increase and multiplier effects weaken.

Once the contractionary effects of loadshedding are incorporated, the employment and growth outcomes become more conservative but remain positive on net. Loadshedding imposes significant indirect costs through lost production time, higher operating expenses and reduced investment confidence—patterns widely documented in South Africa and other Sub-Saharan African economies. When these induced losses are accounted for, the net employment and output gains from renewable energy remain substantial, but the results highlight that a portion of the initial stimulus is absorbed by offsetting economic pressures. This mirrors evidence from forward-looking economic models showing that electricity constraints can suppress the full benefits of infrastructure investment.

A key observation from the analysis is the uneven distribution of impacts across sectors. Energy-intensive industries, notably manufacturing and agriculture, bear the deepest losses under loadshedding but also experience the strongest rebound when renewable-energy supply improves. This suggests that renewable energy plays a strategic role in stabilising the productive core of the provincial economy. Nonetheless, the sustainability of these gains depends on continuity of investment and the ability of firms to integrate more reliable electricity into long-term production planning.

Two important implications arise from these findings. Firstly, policymakers should recognise that loadshedding creates strong induced economic losses that cannot be ignored when assessing the benefits of renewable-energy investment. Ignoring these losses would lead to overly optimistic expectations about the role of renewable energy in driving growth. Secondly, the quality of the jobs and investment generated matters as much as the quantity. While renewable-energy projects create substantial construction-phase employment and stimulate fixed investment, more stable long-term gains require complementary interventions such as grid expansion, skills development and industrial support.

Overall, the results show that renewable-energy investment can play a central role in restoring energy security and supporting inclusive growth in the Eastern Cape. Yet, the province will only capture the full economic benefits if these investments are paired with broader structural reforms that address the persistent vulnerabilities created by loadshedding and weak energy infrastructure.

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