Assessing the Impacts of Low Emission Electricity Investment Senegal: Economy-wide and Distributional Perspectives

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Abstract

Senegal faces high electricity production costs and aims to reduce reliance on the imported oil and improve electricity access by 2025. The study uses a recursive dynamic computable general equilibrium model analyze the economy-wide impacts of the investment in low emission electricity, as well as a top-down microsimulation approach to assess the poverty impacts. The study explores alternative financing options, including domestic private savings, government domestic debt, government financing through foreign aid or bonds and foreign investment. The results indicate that a 15% increase in investment in low emission electricity leads to a reduction of in high emission electricity generation and a significant increase in low emission electricity generation across the alternative financing options. This results in average reduction in the cost electricity production by 6-14%. Additionally, there is a substantial reduction in CO2 emission per unit, demonstrating enhanced emission efficiency in the electricity sector, while revealing nuanced impacts on other industries. The study suggests that investing in electricity generation is likely to raise the country's GDP and welfare, as well as reduce poverty, with foreign aid performs slightly better than other financing scenarios. The increased investment also leads to higher household electricity and food consumption, as well as a reduction in poverty across the households, with a relatively larger reduction observed in urban areas.

Keywords: Low Emission Electricity, Investment, Recursive Dynamic Computable General Equilibrium, Economic growth, Welfare, Poverty, Senegal

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1. Introduction

Senegal is leading in power generation and energy sector reform in the West Africa region by allowing private participation in electricity generation. Despite allowing private participation in electricity generation, the country grapples with some of the highest electricity costs of production in Sub-Saharan Africa. In 20018 and 2019, the cost of electricity generation in Senegal was notably high at US $26 and $18 per megawatt hour (MWh) respectively, compared to the global benchmark of US $10/MWh (IMF, 2022). This is primarily due to the heavy reliance on imported energy, mainly diesel oil, for grid electricity supply, which accounts for a substantial portion of the public electricity utility. Recent increase in international oil prices due to the post Covid-19 supply constraints, and geopolitical turmoil have further exacerbated the pressure on Senegal's electricity tariffs and government subsidies to protect the vulnerable households from higher tariffs (IMF, 2022).

In response to these challenges, the government has initiated the Priority Action Plan Phase II for an Emerging Senegal 2019-2023 (PSE II). This plan aims to achieve economic emergence of Senegal by 2035 and emphasizes increasing investment in infrastructure driven by the private sector. One of the key objectives of the Priority Action Plan is to achieve universal access to reliable and competitively priced electricity by 2025, achieved through the implementation of several electricity generation projects and the development of an energy mix including hydropower, wind power and solar power. Senegal's energy generation capacity has been undergoing a significant transformation. The country has witnessed a substantial increase in its capacity of solar and wind energy generation, from negligible levels to 27% of the country's total installed energy generation capacity in 2020 (Republique du Senegal, 2019, van den Bold, 2022; IRENA, 2022).

Senegal's Gas-to-Power strategy aims to gradually shift away from its energy dependence on oil and coal toward investing in gas as transitional fuel for power generation starting from 2023. The country has leveraged its significant offshore oil and gas discoveries since 2014, introducing liquefied natural gas to its energy mix while expecting substantial reduction its reliance on oil and coal (Saïd Ba, 2018; World Bank, 2019). Supported by t multisectoral reform development financing , Senegal the country has embarked on the phase-out of heavy fuel oil for power generation, targeting a minimum installed capacity of 22% in renewable energy and 64% in gas by 2025 (EITI, 2021; World Bank, 2019).

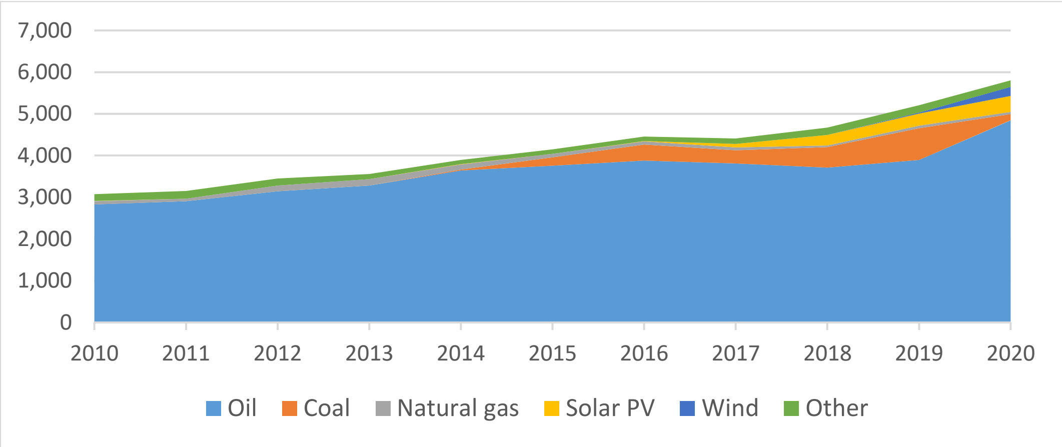
Private sector participation in the energy sector has been actively promoted, through public-private-partnership (PPPs), leading a substantial increase in planned investment in energy infrastructure under the Priority Action Plan. The planned investment of the Priority Action Plan in energy infrastructure has increased by almost 5.5 times from Phase I of PSE (2014-2018) to Phase II (2018-2023). In 2020, the Millennium Challenge Account (MCA-Senegal II) of the Government of Senegal forged a five-year 600 million USD contract with the United States Millennium Challenge Corporation ($550 million MCC and$ 50 million Government of Senegal) to strengthen the country's power sector, including the conversion of existing power plants to gas and/or dual fuel[1].

Senegal's electricity generation has historically been dominated by high-emission based fuels, with oil accounting for 92%-94%of of fuel use between 2010 and 2014 (**Figure 1**). Although coal starts contributing to the Senegal's electricity generation from 2015, the share of high emission electricity generation, consisting oil and coal, has progressively declined as alternative energy sources have gained traction. The International Energy Agency (IEA) in its Africa Energy Outlook (IEA, 2019) projects a substantial increase in gas, followed by renewables to meet the growing share of Senegal's electricity

[1] See https://www.mcc.gov/where-we-work/program/senegal-power-compact

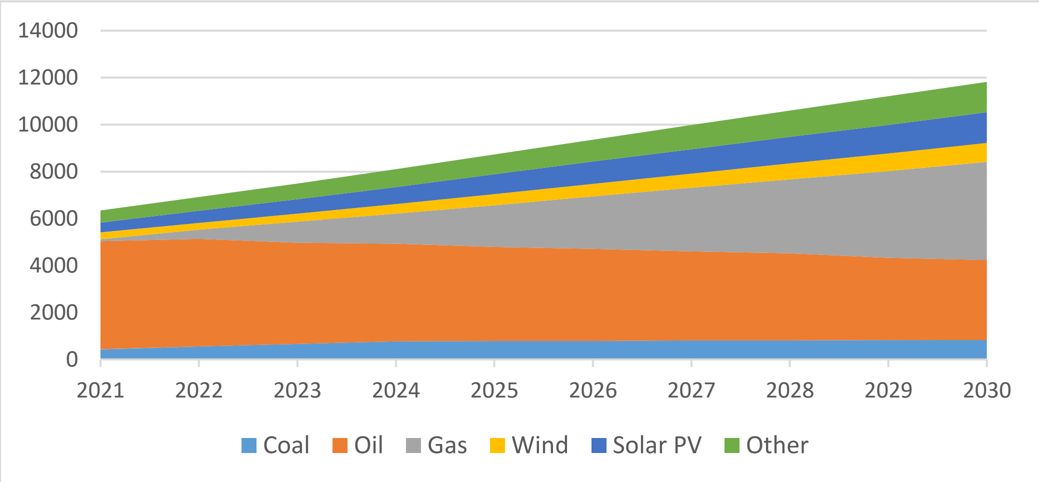
demand with the share of oil-based generation expected to decrease from almost 72% in 2021 to about 46% and 28% in 2025 and 2030 respectively., paving the way for more gas and renewable-based generations (**Figure 2**).

Figure 1. Sources of energy in Senegal electricity generation (GWh).



Source: Adapted from International Energy Agency (IEA) (2019, 2022)

Figure 2. Senegal projected electricity generation by technology (GWh).



Source: Adapted from International Energy Agency (IEA) (2019, 2022)

The transition from heavy oil to natural gas in electricity production is anticipated not only to reduce costs but also to enhance security of supply through the utilization of low-carbon fuel by 2025.[2]. With the finalization of Senegal's Gas Code in 2020 and the implementation of gas-to-power projects, the country is projected to nearly halve its electricity prices by 2023 compared to heavy fuel oils (Energy Capital & Power, 2022). Natural gas is set to become the primary source of electricity for Senegal's systems while facilitating the integration of additional renewable energy sources (RVO, 2022). Senegal is undoubtedly poised to harness significant potential for relatively low-cost gas- and alternative energy-based power generation.

The primary electricity generation sources in Senegal include thermal power plants, which burn petroleum products like diesel and heavy oil, as well as natural gas-fired power plants. These power plants contribute significantly to the country's CO2 emissions. Natural gas is a cleaner-burning fuel

[2] See: https://www.usaid.gov/powerafrica/senegal

compared to petroleum products, emitting less CO2 and other pollutants per unit of energy produced. Besides reducing the cost of electricity, the shift from the heavy oil towards natural gas in the production of electricity is expected to ensure the country's security of supply in terms of low-carbon fuel. As Senegal increases its natural gas capacity, it can gradually replace inefficient oil-fired power plants with cleaner and more efficient gas-fired plants. The transition would help to lower overall emissions intensity of the electricity sector. Hence, Senegal's increased natural gas capacity can facilitate the replacement of inefficient oil-fired power plants with cleaner and more efficient gas-fired plants, consequently lowering the overall emissions intensity of the electricity sector.

Moving away from the country's dependence on inefficient high emission electricity generation (**HEEG**), based on oil and coal towards low emission electricity generation (**LEEG**) investments including ,including mostly natural gas-based energy, is poised to have far-reaching impacts on national economy and households. To analyze these potential effects, a recursive dynamic computable general equilibrium (CGE) model is employed, providing insight into the economy-wide interlinkages and transmission of investment impacts on electricity (Dissou and Didic, 2011; Borojo, 2015).

The model captures the economy-wide interactions and feedback effects between different sectors, including electricity generation and CO2 emissions. However, the sign and size of the impacts could depend on the sources of financing and the adjustment mechanisms to the possible crowding out effects of investment in large scale projects. Boccanfuso et al. (2014) conducted a comparative analysis of funding options (government debt, and debt with different types of taxes) for public infrastructure spending in Quebec and found no large differences in the growth effect between the options; however, there existed distributional differences. An earlier study by Issoufou et al. (2014) analysed the impacts of financing electricity investment in Senegal with different sources of government financing and adjustment programmes. Boccanfuso et al. (2009) discussed the distributive impacts of different electricity price reforms in Senegal through different ways of transfer programmes. Borojo (2015) examined the impacts of investment in electricity infrastructure in Ethiopia with alternative finances (domestic private and foreign savings). Assessing the investment in hydropower investment in Ghana, Nechifor et al. (2022) illustrate the economy-wide effects of financing conditions which are of the same scale as those resulting from the additionally generated electricity.

This study utilizes a recursive dynamic CGE model to analyze the economy-wide impacts of envisaged investment in the low emission power generation within the Senegalese economy. It investigates the impacts on economic growth, welfare, distribution, and effectiveness of CO2 emission reduction, considering alternative financing sources such as domestic private, government and foreign savings, and government financing through increasing foreign aid or grants. Employing a top-down microsimulation approach the study also analyses the poverty alleviation impacts.

The remainder of the paper is organized as follows. Section 2 provides an overview of the data utilized, offering a summary description of the structure disaggregation details specific to Senegal. Following this, an explanation of the model employed, namely the single country Dynamic Equilibrium Model for Economic development Resources and Agriculture (DEMETRA), is presented. Additionally, this section outlines the microsimulation module employed for the poverty analysis. Moving on to Section 3, various scenarios and the results are discussed. Finally, Section 4 presents the concluding remarks.

2. Data and CGE Model

The research utilizes a single-country recursive dynamic CGE model, designed to capture the long-term economy-wide impacts of investing in low emission electricity infrastructure. The model is calibrated using the social accounting matrix (SAM) for the year 2014, which is subsequently updated to 2021 using recursive dynamics (Mainar Causapé et al. 2018).. The SAM serves as a comprehensive, economy-wide database, depicting economic transactions among various agents within the Senegalese economy. It includes highly disaggregated data on 61 activities producing 61 marketable goods and services, as well as 14 regional subsistence crop producers generating 9 non-marketable food crops. Additionally, it features the disaggregation of representative households into 14 regions, reflecting the administrative divisions of the country. The SAM also specifically accounts for two types of electricity generation: high emission electricity generation (**HEEG**) and low emission electricity generation (**LEEG**). This framework enables the specific analysis of production and productive factors for each region, making a distinction between rural and urban areas. It also facilitates examining the interrelationship between the production structure and the distribution of incomes among different household groups, thus providing a comprehensive analysis of the impacts within regions.

The model utilized in this study is based on the single-country Dynamic Equilibrium Model for Economic Development, Resources, and Agriculture (DEMETRA), initially proposed by McDonald et al. (2016) and subsequently refined by Boulanger et al. (2020). Its core features encompass a flexible CES nested production function, incorporating home production for home consumption, distinguishing between marketable and semi-subsistence production activities. Additionally, it integrates a flexible CES-LES household demand system and factor market segmentation across sub-national regions. The model considers multi-product activities utilizing various production technologies, with fixed factor supplies at an aggregate level, while their mobility across activities remains unrestricted.

Households in the model adhere to a two-level utility functional form. The first level comprises the Stone-Geary LES utility function, encompassing subsistence and discretionary demand for all natural and broad commodities. The broad commodity groups in the LES function aggregate natural commodities like food crops, livestock, and processed food, each assumed to have distinct levels of subsistence demand. The second level features a CES utility function, defining the quantities of aggregated or broad commodity groups demanded by each household in the top-level LES utility function. Notably, electricity consumption is excluded from the 'broad' commodity group. Regional marginal farmers both consume and sell their produce (HPHC) in the market at basic prices.

Under the standard small country assumption, the country acts as a price taker for imports, unable to influence world prices. Exported and imported goods are distinct from the domestically produced goods, with domestic production exportable through a constant elasticity of transformation (CET) function and foreign goods substituting the domestic produce through a constant elasticity of substitution (CES) function, aligning with the Armington assumption for trade (Armington, 1969) . The balance of payment constraint incorporates fixed foreign savings valued in foreign currency, while the exchange rate of the domestic currency is market-determined.

For the model dynamics, the capital in each sector is updated at annual time steps with capital depreciation and investments from the previous period accounted for. Capital is divided into fixed and mobile components. Once fixed capital is allocated within an activity, it can exit that activity by economic or accelerated depreciation, while newly formed capital enters a pool allocated across activities based on sector-specific return to capital. The business-as-usual (BAU) scenario mimics the long run expected growth, encompassing forecast of several macro aggregates such as GDP, investment, savings, and world prices.

In this study and hence, in the SAM, it is assumed that electricity as a composite marketable commodity produced by two technologies: high emission electricity generation (**HEEG**) and low emission electricity generation (**LEEG**). These two types of generation are not perfectly substitutable, and hence are aggregated by a constant elasticity of substitution (CES) function (**Figure 3**), with an elasticity value of 6, closely aligning with the OECD's ENV-Linkages model (Château et al., 2014). The aggregated electricity as a single commodity meets the demand for electricity from various agents.

The production technology of each activity involves different stages of input aggregation as in **Figure 3**. The total primary factor endowment (value-added) is a CES aggregation of land, labour and capital, combined with electricity in a CES aggregate endowment-electricity technology. At the highest level of aggregation for the final output, there is substitutability between composite endowment-electricity input and combined non-electricity input. The model assumes a savings-driven capital account whereby saving rates (domestic private savings) are fixed, and the value of total investment adjusts to equilibrate the total savings. With the fixed world prices and fixed foreign savings, the endogenous exchange rate maintains current account balance equilibrium. The government account balance assumes fixed government savings, tax rates and transfers, while the volume of government consumption expenditure and income are allowed to vary to ensure the government account balance. However, savings closures are altered with the assumption on different financing options in each simulation.

The fixed investment demand is disaggregated by investment demand in **LEEG** electricity and other sectors. The increase in the quantity of fixed investment in electricity enters the capital accumulation accounting that is updated annually between consecutive modelled time steps. For this analysis, electricity investment targets the **LEEG**. To include the investment scale effect on **LEEG** efficiency, higher investment on the infrastructure in **LEEG** is translated into an increase the total factor productivity (TFP) of the specific electricity activity (Eq1). The increase captured by $\gamma_{t,LEEG}$ depends on the elasticity of the TFP parameter with respect to the electricity investment in **LEEG** as in Eq2.

$$VA_{t,LEEG} = \gamma_{t,LEEG} CES\left(L_{t,LEEG}, K_{t,LEEG}, N_{t,LEEG}\right) \qquad (Eq1)$$

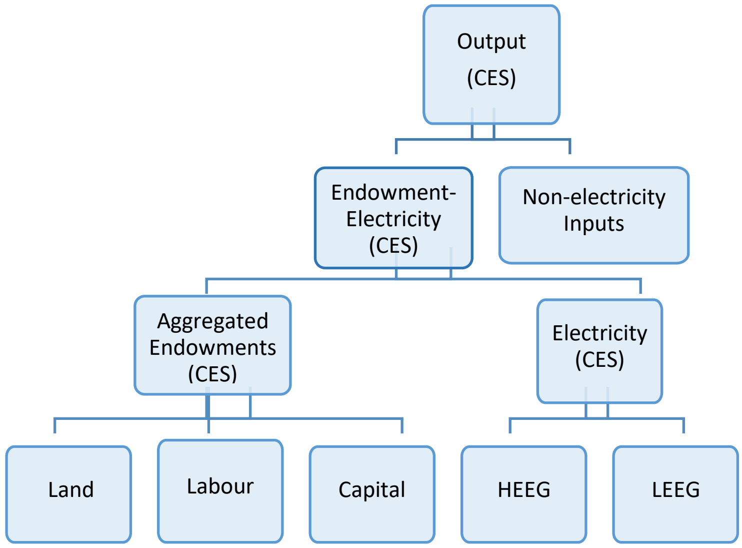
$\gamma_{t,e}$: Scale TFP parameter
L : Labour
K : Capital
N : Land
t , e : Subscripts t and e indicate electricity activity, e, in time period, t

The equation below captures the impact of investment change on the TFP of LEEG production.

$$\gamma_{t,LEEG} = \gamma_{t,LEEG}^{0} \left(\frac{QINV_{t,LEEG}}{QINV_{t,LEEG}^{0}}\right)^{\varepsilon} \qquad (Eq2)$$

$QINV_{t,e}^{0}$, $QINV_{t,e}$ and ε are the base quantity of investment in low emission electricity generation infrastructure, simulated investment and elasticity of TFP with respect to the investment.

Figure 3. Production structure of activities in the DEMETRA model for Senegal.



2.1.Microsimulation Poverty Analysis

The study uses a top-down approach of linking macro CGE impacts to the microsimulation model for the poverty analysis (Ahmed and O'Donoghue, 2019; Cockburn et al., 2010). The CGE model gives household expenditure by 28 representative urban and rural household categories across 14 regions. The detailed micro household consumption for Senegal is based on the survey data from the Harmonized Survey on Households Living Standards (EHCVM) 2018-2019 (ANSD, 2021). The changes in the real consumption of the representative households from the CGE model are fed into corresponding detailed households at the micro level. The link between the CGE and microsimulation models requires mapping between the representative households in the CGE model and the micro households in the survey. Based on the new consumption expenditure across commodities in each scenario, real per capita and total consumption expenditure are recalculated for each micro household in the survey. The micro-simulation maintains the share of each commodity in total expenditure for each micro household before and after the shocks. The after-shock new levels of real consumption expenditure are contrasted against the given poverty line for the poverty estimates.

The annual poverty based on the minimum vital needs is set at a value of FCFA 333,440 (ANSD, 2021). The EHCVM 2018-2019 survey gives the benchmark poverty estimates based FGT measures (Foster et al., 1984). Poverty impacts are evaluated based on the three types of FGT poverty measures: poverty head-count ratio or poverty incidence, i.e. number of people below the poverty line (P0); poverty-gap, i.e., ratio by which the mean consumption of the poor falls below the poverty line (P1); poverty severity, i.e., assigning higher weights on the poverty of the poorest individuals (P2). The most commonly used poverty measure is the poverty incidence or head-count ratio (P0).

3. Scenarios and Results

3.1.Scenarios

The benchmark database has been updated to 2021, and the business as usual (BAU) scenario of the model is projected to the year 2025 based on exogenously determined baseline GDP, investment, and world prices growth rates. The baseline projections of low emission electricity generation (LEEG) and high emission electricity generation (HEEG) have been adjusted to follow the projections from the International Energy Agency (IEA) in 2019 and 2022. As per the BAU calibration, the share of high emission fuel-based electricity generation in the total generation has decreased from 95% in 2014 to almost 22% in 2021.

Drawing from the proposed investment plans of the Priority Action Plan for Senegal (PSE) over 2014-2018 and 2019-2023, the average annual rate of investment in energy infrastructure is approximately 15%. In the investment scenarios, an indicative average 15% increase in investment in LEEG from 2021 to 2025 is applied, assuming that investment would be commissioned each year, not only for the installation of new plants but also for capital expansion, maintenance, and transmission[3]. Various alternative saving closures, such as domestic private savings (**DomFin**), government savings representing government borrowing from the domestic market (**GovDebt**, and the current account balance or foreign savings (**ForInv**) are considered to fund the increase in investment in LEEG. apital through its current account surplus, are considered to fund the increase in investment in LEEG.

In addition to the simulations with the alternative savings closures, the study includes another simulation where the government finances the investment in LEEG through purchasing foreign bonds (ForBonds). Unlike foreign savings in the current account balance, foreign bonds enter the government account balance. When government issues foreign bonds, it is essentially borrowing money from international investors and funds raised are used to finance government expenditures, including investment projects. For example, the government of Senegal can receive grants from international funds, like Global Environment Facility (GEF) or mobilize financial resource by floating bonds to foreign agents (e.g., through Sustainable Development Bond in the international market)[4]. In this simulation, the increase of investment in electricity is combined with an increase in foreign bonds to the same amount, while government savings are allowed to vary. It's important to note that the model does not explicitly address the interest payment toward the debt services in raising financial resources either through domestic borrowing or foreign bonds, assuming that the government uses its fiscal reserves (savings) to service the debt, including making interest payments and repaying the principal amount borrowed.

The results of the policy shock in the scenarios are evaluated against the baseline scenario for the year 2025. The simulations considered for our analysis are as follows:

Sim 1 - Domestic private finance (DomFin): Domestic private saving rates adjust to finance the 15% increase in investment in LEEG, while government and foreign savings are fixed, i.e., they grow at BAU.

Sim 2- Financing through domestic debt (GovDebt): Increase in investment in LEEG by 15%, with government savings free to adjust (endogenous) while private saving rates and foreign savings are fixed.

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[3] Based on the model baseline information, the baseline investment on electricity project is considered to be 160,000 million Francs CFA, and a 15% increase in the investment in the electricity comes about 24,000 million FCFA per year between 2021 until 2025. Hence, it accounts for FCFA 280,000 million of investment in total. According to Senegal Emergent (2023) report, the total proposed partnership investment opportunities on gas pipeline network in Gas-to-Power Strategy is about USD 500 million, which is around 275,000 FCFA at the 2021 exchange rate of 550 FCFA for one USD.

[4] For example, Banque Ouest Africaine de Développement (BOAD), the regional development bank of the member states of the West African Economic and Monetary Union (WAEMU), has issued the Sustainability Bond in Africa with a 12-year maturity (https://gsh.cib.natixis.com/our-center-of-expertise/articles/boad-issued-the-first-ever-sustainability-bond-in-africa). In 2021, Benin launched its inaugural Sustainable Development Goals Bond €500 million for 12.5 years with the final yield 5.2% and at a coupon rate of 4.9% (https://gsh.cib.natixis.com/our-center-of-expertise/articles/republic-of-benin-s-trailblazing-500m-12-5-y-inaugural-issuance-under-its-new-sdg-bond-framework).

Sim 3: Financing through foreign aid (ForBond): Increase in investment in LEEG by 15% with the increase in government financing through foreign bonds, while government savings are free to adjust, and private saving rates and foreign savings are fixed.

Sim 4: **Financing through foreign capital (ForInv):** Increase in investment in LEEG by 15% with foreign savings to adjust (endogenous), while private saving rates and government savings are fixed.

A study by the International Energy Agency (IEA) in 2008 indicates that the global average efficiencies of electricity generation are approximately 40% for natural gas, and between 34% and 37% for coal and oil. Furthermore, a separate study by ECOFYS in 2018, focusing on a select few countries, found that gas-fired electricity generating efficiencies ranged from 38% to 57%, coal-fired from 35% to 42%, and oil-fired from 28% to 42% (Nierop and Humperdinck, 2018). These studies provide insights into the varying efficiencies of different electricity generation methods.

Senegal has cultivated a robust investment environment for the development of electricity infrastructure towards low emission electricity generation, and this trend is expected to continue in the future. Investment in low emission electricity generation is anticipated to shift the production frontier through the expansion of existing technologies and the adoption of new ones, as well as the development of alternative energy sources to deploy low emission energy-mix technology. Consequently, the model assumes a higher elasticity of Total Factor Productivity (TFP) - specifically, a value of 1.1 - with respect to investment in low emission electricity generation.

It is important to note that the value of the elasticity of TFP with respect to electricity investment may vary depending on factors such as the quality of infrastructure, the level of competition in the electricity sector, the regulatory environment, and other relevant factors. For instance, Eberhard et al. (2011) estimated a very low elasticity of TFP with respect to electricity investment in Mali, specifically at 0.13. This suggests that the elasticity value can be context-specific and may differ across regions and countries. In the context of the model, a sensitivity analysis is conducted to consider the elasticity within a range of lower to higher values between 0.6 and 1.4. This analysis is presented below in a sub-section of results, tracing the overall response of the economy to changes in the values of elasticity.

3.2.Results

Macro-indicators

The increase in investment on LEEG shows over all positive changes across macro variables (**Figure 4**). Financing though different instruments in our model has only marginal differential impacts on country's GDP 2025. GDP increases by around 1.8%, slightly more in case of financing though foreign bond (**ForBond**) than the other scenarios. Domestic final demand, including the government consumption, increases the most when government finances the investment though foreign aid in **ForBond**. On the other hand, increase in the domestic demand, including household as well as government consumption, is the lowest in case of foreign investment though current account balance in **ForInv**. Government consumption expenditure increases considerably in **ForBond** as government income expands due to flow of foreign bond, while it is the lowest when current account surplus is used to finance the investment. Household consumption increases the most (1.3%) in case of financing though domestic savings in **DomFin**, while the lowest increase (0.93%) is observed in **ForInv**. The increase in household consumption demand may be explained by the increase in the household income.

The GDP increase across the different simulations is attributed to the increase in the domestic demand. The results highlight that investing in the electricity generation facilitates the larger increase in the demand of intermediate inputs required for the domestic production. There is a positive and almost equal impact on the trade balance in **DomFin** and **GovDebt** simulations. In both scenarios, imports increase by around 2.5% and exports by almost 3.7%. The highest growth rate for exports (4.1%) and the lowest growth rate (2.3%) are registered in **ForInv** simulation. This is because the real exchange rate increases relatively more in **ForInv** (0.4%) than the other simulations. Exchange rate in the model represents the relative prices of tradable to non-tradable goods and services. In the ForBond simulation, where the government financing the investment through foreign bond in **ForBond**, the increase in the real exchange rate is marginally lower (0.2%) than the other simulations. This, leads to relatively slightly lower exports (3.4%) and higher imports (2.6%) compared to the other simulations.

Productive sectors

Increasing investment in low emission electricity generation by an average of 15% annually from 2021 to 2025, relative to the baseline, leads to a shift from high emission electricity generation to a substantial increase in low emission electricity generation across all alternative financing scenarios (Table 1). By 2025, the supply of low emission electricity sees a significant rise of 42%-43% compared to the baseline, resulting in a nearly 15% decline in high emission electricity across the simulations. The substantial investment in low emission electricity also brings about a noteworthy reduction in production costs, averaging about -14% compared to high emission electricity, which sees a reduction of about -6% across the simulations.

The increased availability of electricity at a relatively lower cost fosters its use as an intermediate input in various production activities. In the baseline scenario, service sectors consume nearly 63% of the available electricity supply, followed by manufacturing industries at 34%, with agriculture utilizing the least at 0.2% (**Table 2**). Following the increased investment in low emission electricity, demand for electricity by the service, industrial, and agricultural sectors increases by an average of 73%, 72%, and 42% respectively across the simulation options.

Examining the sectoral impacts of increased electricity investment in **Figure 5** and **Table 3** reveals a substantial expansion in aggregate electricity supply and domestic demand across the simulations, averaging 38%, while domestic electricity prices experience an average decline of 12.7%. Conversely, domestic prices of non-electricity sectors rise in all simulations. This increase in domestic prices can be attributed to the expansion in aggregate income and demand, leading to increasing competition for factors of production (e.g., labour) in non-electricity activities. However, the greater availability of low-cost electricity as a critical input in various economic activities drives up domestic demand across sectors. Major users of electricity, such as cash crops, manufacturing activities (including processed food, petroleum, and chemicals), and services, all benefit from the increased investment in low emission electricity.

Table 4 outlines the impacts of investment in low emission electricity generation on tradable sectors. Sectors such as cash crops, processed food, chemicals, and petroleum become more competitive in exports due to the lower cost of production resulting from availability of lower cost electricity. The food processing industry experiences the highest growth in exports in all simulations. The increased demand for intermediate inputs leads to higher imports of cash crops, mining, and industrial products. Overall, imports across the board increase due to the rise in domestic prices of non-electricity sectors alongside increased domestic demand. It is noteworthy that the rice and livestock sectors are not competitive in terms of exports, and their export performance is weaker compared to other sectors.

However, imports of these sectors increase across the simulations due to spill over effects from the processed food industries, as rice and livestock are used as intermediate inputs, leading to a rise in imports for these sectors.

Households

The expansion of electricity activities and its subsequent effects on other economic sectors have a positive impact on factor returns and, consequently, on household income. Table 5 illustrates the effects of increased electricity investment on factor returns and household income. Across all simulation cases, the return to labour exhibits a greater growth compared to other factors. Notably, the case of foreign borrowing in **ForBond** results in a larger increase in labour income. Urban households, excluding Dakar, experience relatively higher gains compared to other households, followed by rural households in the Dakar region. Generally, households benefit the most when financing from foreign bond is increased to support increased investment. .

In terms of electricity consumption, it is evident from Figure 6 that both rural and urban households in Senegal benefit from the increased production of electricity at a significantly lower cost. Household electricity consumption sees substantial growth across all simulations, averaging over 14%. In the **DomFin** and **DomBond** simulations, the increase in household electricity consumption is slightly higher compared to the **GovDebt** and **ForInv** simulations, attributed to their relatively higher income growth compared to other scenarios.

Figure 7 underscores the impacts of investment in low emission-based generation on food and other non-electricity consumption expenditure by households. The rise in household factor income due to increased electricity and other sector activities is the primary driver of increased real consumption, outweighing the price effects. Despite a noticeable increase in sectoral non-electricity prices in all simulations, consumers may benefit from the increased availability of imported commodities. As expected, there is substantial growth in electricity consumption, while the growth in non-electricity consumption is comparatively lower. The consumption of non-electricity goods and services, excluding food, experiences a greater increase compared to food consumption. This can be attributed to the spill-over effects of increased investment stimulating economic activity in non-food sectors and subsequently driving up their consumption levels. Although food consumption increases across households, the rise is marginal, with rural households experiencing lower gains in both food and non-food consumption compared to urban households

Household welfare, as equivalent variation in percent of base income, depicts changes in the welfare of representative households across the 14 regions in Senegal (**Figure 8**). Similar to the income gain effects, relatively lower increases in welfare are observed when financing with foreign investment (**ForInv**), while financing through foreign bonds (**ForBond**) fares better across other scenarios. With the increase in investment in electricity, larger welfare gains are observed for urban households, with the regions of Kaolack, Louga, Saint-Louis, Fatick, and Diourbel experiencing relatively higher welfare gains compared to other regions.

3.3.Poverty Results

In the baseline 2025, the national poverty incidence is 21.5%, with about 33% poor people live in rural Senegal. Dakar, the most populated region with 14% of the population, is largely urban and has the lowest poverty incidence compared to other regions. In terms of poverty incidence impact in **Table 6**, results show that the investment in low emission electricity infrastructure has shown to have potential to mitigate poverty in Senegal. Under business-as-usual assumption, poverty incidence decreases with an increase in economic growth. The highest poverty incidences are observed in Sédhiou (50%), Kédougou (41 %), Tambacounda (35.7%), Kolda (32.5%) and Fatik (32%) regions in 2025. However, the poverty impacts of investing in electricity are not large enough to significantly vary across the simulations and regions[5]. Some of the regions, such as, Dakar, Saint-Louis, Louga and Kaffrine, do not experience any changes in poverty, possibly, because poor households in these regions may be living farther away from the poverty line and may require larger shocks to escape poverty. National poverty declines by approximately 0.30-0.32 percentage points over the simulations, with Poverty reduction appearing to be higher in urban areas compared to rural areas Senegal. At the regional level, poverty reduction effects are relatively higher in Matam, Ziguincho, Tambacounda, Thiès and Sédhiou regions.

Investing in low emission electricity generation is also likely to reduce both poverty gap or poverty depth (P1) and poverty severity (P2) (**Table 7** and **Table 8**). If higher weight is given to the poverty gap (P1) or poverty severity (P2) as in Foster et al (1984), households in all the regions benefit in terms of poverty reduction. However, it is seems that poverty gap and severity are more prevalent in rural areas than in urban areas. The average consumption shortfall of household below the poverty line is reduced, with relatively larger gains accrued to the households in Matam, Ziguincho, Thiès and Sédhiou (**Table 7**). Additionally, poverty severity is relatively higher in Kédougou, Sédhiou and Tambacounda regions **(Table 8).** Compared to the poverty incidence, the reduction impacts are lower in case of poverty severity as chronically poor households dwell farther away from the poverty line.

Table 9 presents the number of poor likely to be lifted out of poverty with the increased investment in LEEG. The study suggests that utilizing domestic private savings (DomFin) and raising foreign bonds (ForBond) to support LEEG investment could potentially lift around 52,000 poor individuals out of poverty at the national level. This is in comparison pares to about 47, 615 and 48,621 individuals if government debt and foreign savings, respectively, are used to finance the investment. Regionally, the Diourbel and Thiès regions have the highest concentration of poor, 4999,338 and 381,562, respectively in the year 2025. However, the investment in LEEG has the most significant impact in the Thiès region, lifting about 17,102 individuals above the poverty line, followed by Matam with 10,330. Despite having the highest concentration of poor population, the Diourbel region sees a lower number of individuals lifted out of the poverty line. In addition, although Sédhiou has one of the highest poverty incidences,, the investment has only limited impact on lifting poor individuals out of poverty (**Table 6**). Please note that these regions also have higher poverty severity, where poor people are farther away from the poverty line (**Table 8**) and impacts are not enough to move the poor above the poverty line.

3.4.Emission Impacts

The CO2 emissions resulting from the use of energy commodities by different activities, including electricity generations, and households are assumed to be linear function of the quantity of the energy commodity used, following the methodology proposed by MacDonald and Thierfelder (2016) and McDougall and Golub (1998). The coefficient in the equation defines the CO2 emissions per unit of the energy commodity. The emission intensity represents the amount of CO2 emitted per unit of energy produce or consumed. The base energy intensities are calculated using GTAP11-e database, 2017 (Aguiar et al., 2023), utilizing the volume of energy inputs used in the production process of different activities and the corresponding CO2 emissions from each energy input, such as coal, oil and gas.

Table 10 provides insights into the potential impacts of different scenarios on CO2 emission efficiencies, that is, emissions per unit of production across various activities, and households in

[5] Please note that poverty lines remains the same across the regions, both for urban and rural.

2025. Looking at the sectoral share of emissions in the baseline for 2025 reveals that sectors such as electricity generation, transportation and mining contribute a large share of total CO2 emissions. Investing in low emission electricity generation has a particularly strong effect on the electricity sector, with a substantial decrease in CO2 emissions per unit of electricity generated across all scenarios, indicating that electricity generation has become considerably CO2 efficient. This is significant compared to other sectors, with a percentage change of -15% in CO2 emissions. On the other hand, sectors such as mining, processed food, chemicals and other manufacturing activities are also expected to become, to some extent, CO2 efficient by decreasing in CO2 emissions per unit of their respective production activities, albeit to a lesser extent. Conversely, the construction and transport sectors are projected to experience minimal changes in CO2 emissions. Within the agricultural activities, there is an observed increase in CO2 emissions in the traditional marginal farming activities. The increase can be attributed to the predominant use of fossil fuels such as oil and coal as part of their intermediate production processes. The investment in low-emission electricity, while intended to reduce overall CO2 emissions, has resulted in higher demand for production, subsequently leading to an increased use of fossil fuels in these traditional marginal farming activities.

Results in **Table 10** indicates a general increase in CO2 emission from overall activities and households, despite improvements in emission efficiencies in electricity and some other activities through investment in low-emission electricity generation. This rise in total CO2 emissions can be attributed to several factors, including the potential expansion of energy-intensive sectors like construction and transportation due to higher economic growth from low-emission electricity investments. Additionally, the use of energy-efficient technologies and low-emission electricity may lead to cost savings, resulting in increased consumption and higher energy usage, thus contributing to increased CO2 emissions from households.

3.5.Sensitivity Analysis

The impacts of investment in the low emission electricity infrastructure on the total factor productivity of LEEG depends largely on how sensitive the TFP is with respect to the investment, with results being sensitive to the choice of the elasticity ε in **Eq2**. In a conducive environment, a unit increase of investment would deliver a higher TFP than in a lacklustre environment. In the absence of proper and exact information on the elasticity, we assumed a base value of 1.1, reflecting a higher conducive and efficient production environment in investing in LEEG. In order to support the robustness of the chosen elasticity, a sensitivity analysis is conducted where for each simulation we systematically change the elasticity from lower to higher. The four sets of simulations are run with the elasticity values starting from a lower level of 0.6 to the higher level of 1.4.

Figure 9 and **Figure 10** display impacts of investment in low emission electricity generation with respect to changes in values of elasticity on low and high electricity generation and on their prices, respectively. It is seen that with the increase in the elasticity, there is an increasing growth in low emission electricity generation. There is a clear increasing pattern of growth with the increasing values of elasticity; however, however, with the elasticity values above one, the growth is slightly less steep than the values less than one. With the increase in values of elasticity, similar declining pattern of growth is observed in case of high emission electricity generation, and prices of both high and low emission power generation.

4. Concluding remarks

With the exploration and production of more natural gas, and the policy of moving away from the traditional oil and coal-based power generation towards gas-to-power generation, Senegal is encouraging higher investment in low emission electricity infrastructure, including gas-based generation. Using a recursive dynamic CGE model in DEMETRA framework, this paper attempts to analyse the impacts of investing in low emission electricity on growth, distribution, and welfare in Senegal. The study investigates the effects of investment under four alternative financing designs by alternating assumptions on savings. Simulations are conducted from the year 2021 until 2025 and impacts examined for the year 2025. The study also applied a microsimulation approach by linking the micro households to the representative households in the CGE to assess the poverty impacts of the simulations.

An increase in investment by 15% results in overall growth in the real GDP, trade and domestic demand. Although there is only marginal differential GDP impacts across the scenarios, slightly larger growth is observed when higher investment is accompanied by government's financing the investment through increased foreign aid, while it is the lowest when allowing the foreign savings to vary with the increased investment. The pattern of GDP growth is largely driven by the expansion in aggregate domestic demand including household, government and intermediate demand. However, trade balance is relatively lower with the foreign aid financing and higher in case of endogenous foreign savings. This is mainly because of relatively lower real exchange rate in case of increased foreign aid and higher when financing through foreign investment.

Irrespective of alternative financing options, investing in low emission electricity raises the low emission electricity production by about 43% and reduces the high emissions generation to the extent of 15%. The production costs of both high and low emission electricity decline by 6% and 14%, respectively. Sectors that are major users of electricity like cash crops, processed food industries, other manufacturing, and services gain in production. Among the exporting industries, most benefit accrues to the food-processing sector followed by chemicals, cash crops, petroleum and other manufacturing industries as these industries become more export competitive. The significant increase in electricity production due to increased investment in low emission electricity and the resulting decline in the cost of electricity puts a pressure on sourcing factors of production in non-electricity activities, leading to increase in the prices of non-electricity sectors.

Households benefit not only from increased electricity consumption, but also increase in their food consumption. The rise in both food and non-food consumption is at its lowest in case of financing through foreign investment. This is because in this scenario, there is relatively larger increase in the prices of non-electricity goods due to the relatively greater increase in real exchange rate. The Increased investment in low emission electricity generation affects household welfare positively. In general, relatively higher welfare gains are registered for the urban households than their rural counterparts, and major gains are experienced from foreign bond financing.

The microsimulation poverty analysis in the study has revealed that investing in low emission electricity infrastructure has the potential to mitigate poverty in Senegal. The results indicate that national poverty incidence is projected to decline with the increase in economic growth, with the highest poverty incidences observed in specific regions like Matam, Ziguincho, Tambacounda, Thiès and Sédhiou. While poverty reduction effects are relatively higher in urban areas compared to rural areas, the investment in low emission electricity generation is also likely to reduce both poverty gap and severity, particularly benefiting households in certain regions. Additionally, the study suggests that investing in low emission electricity infrastructure can lift a significant number of poor people out of poverty at the national level, with varying impacts across different regions.

It is also evident from the study that investing in low-emission electricity generation, which is mostly gas based, can significantly reduce CO_2 emissions per unit of electricity generated. However, this positive impact is offset by minimal changes in CO_2 emissions in sectors such as construction and transportation and overall increase in total CO_2 emissions from combined activities and households. These findings underscore complex interplay of economic growth, energy demand, and emission efficiencies in shaping CO_2 emissions trends. However, it should be noted that the low-emission electricity generation in the study includes mostly the gas based generation. Natural gas is considered to be relatively cost effective and cleaner fossil fuel compared to coal and oil in terms of CO_2 emissions. However, integrating alternative renewable energy sources, can further enhance the sustainability of energy mix.

In conclusion, the paper presents a comprehensive analysis of the impacts of investing in low emission electricity infrastructure in Senegal. The study highlights the potential for overall economic growth and poverty reduction as a result of increased investment in low emission electricity. The study also emphasizes the need for consideration of the complex interplay of economic growth, energy demand, and emission efficiencies in shaping CO_2 emissions trends. Overall, the study suggests that promoting low emission electricity generation infrastructure has potential to contribute to both economic and social development while also addressing environmental concerns in Senegal.

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TABLES

Table 1. Impacts on high emission and low emission electricity generations and producer's prices (percentage change from the base 2022-2025).

	HEEG				LEEG			
	DomFin	**GovDebt**	**ForBond**	**ForInv**	**DomFin**	**GovDebt**	**ForBond**	**ForInv**
Production								
2022	-26.5	-26.6	-26.4	-26.6	43.2	43.1	43.6	43.0
2023	-23.4	-23.4	-23.3	-23.5	40.7	40.6	41.0	40.3
2024	-19.4	-19.4	-19.3	-19.5	40.8	40.7	41.1	40.3
2025	-15.3	-15.3	-15.2	-15.4	42.6	42.6	42.9	42.1
Prices								
2022	-3.9	-3.9	-4.0	-3.8	-14.0	-14.0	-14.1	-14.0
2023	-4.8	-4.8	-4.9	-4.8	-14.0	-14.0	-14.1	-13.9
2024	-5.6	-5.6	-5.7	-5.5	-14.0	-14.0	-14.0	-13.9
2025	-6.1	-6.1	-6.2	-6.1	-13.9	-13.9	-14.0	-13.8

Source: Own elaboration.

Table 2. Impacts on intermediate demand of electricity by activities.

	Base year 2021 (Share in total demand)	**Intermediate demand (% change from the baseline 2025**			
		DomFin	**GovDebt**	**ForBond**	**ForInv**
Agriculture	0.02	42	42	42	42
Mining	0.01	74	74	73	75
Industry	0.34	72	72	71	72
Services	0.63	73	74	75	72
Trade	0.13	80	81	81	80
Public admin	0.09	79	83	87	78

Source: Own elaboration.

Table 3. Impacts on domestic demand and prices (percentage change from the baseline 2025)

	Domestic demand				Domestic prices			
	DomFin	**GovDebt**	**ForBond**	**ForInv**	**DomFin**	**GovDebt**	**ForBond**	**ForInv**
Crops	1.1	1.1	1.1	1.0	0.8	0.7	0.7	1.0
Rice	0.5	0.5	0.6	0.3	0.5	0.4	0.3	0.6
Other food Crops	0.6	0.6	0.7	0.5	1.0	0.8	0.7	1.0
Cash crops	5.5	5.6	5.3	6.0	0.7	0.7	0.6	0.8
Livestock	0.4	0.4	0.5	0.4	0.8	0.7	0.5	0.8
Forest	0.7	0.6	0.7	0.6	0.5	0.4	0.4	0.5
Fish	0.4	0.3	0.4	0.3	0.3	0.2	0.2	0.3
Mine	2.2	2.2	2.0	2.4	0.3	0.3	0.2	0.4
Industries	2.5	2.5	2.5	2.4	0.3	0.4	0.3	0.5
Processed meat	0.9	0.8	0.8	0.8	0.6	0.5	0.5	0.6
Other processed food	2.1	2.0	2.0	2.1	0.3	0.2	0.1	0.3
Petroleum	4.2	4.1	4.1	4.0	0.3	0.3	0.2	0.4
Chemicals	4.6	4.7	4.7	4.8	0.1	0.1	0.0	0.3
Other Manufacturing	2.2	2.3	2.5	2.2	0.3	0.2	0.3	0.4
Electricity	37.8	37.8	38.1	37.4	-12.7	-12.7	-12.8	-12.6
Construction	1.2	1.2	1.2	1.2	0.4	0.4	0.3	0.4
Services	1.9	2.1	2.3	1.8	0.6	0.6	0.6	0.6

Source: Own elaboration.

Table 4. Impacts on exports and imports (percentage change from the baseline 2025).

	Volume of exports				Volume of imports			
	DomFin	**GovDebt**	**ForBond**	**ForInv**	**DomFin**	**GovDebt**	**ForBond**	**ForInv**
Crops	0.8	1.0	1.0	0.9	2.8	2.6	2.5	2.7
Rice	-0.3	0.0	0.2	-0.2	1.2	1.0	1.1	0.9
Other food crop	0.4	0.4	0.5	0.4	0.9	0.7	0.8	0.5
Cash crop	5.4	5.5	5.2	5.9	5.4	5.3	5.0	5.8
Livestock	-0.6	-0.4	-0.3	-0.5	1.4	1.2	1.2	1.3
Forest	0.2	0.3	0.1	0.5	1.1	0.9	1.1	0.6
Fish	0.4	0.5	0.5	0.5	0.3	0.1	0.2	0.0
Mine	0.8	0.7	0.3	1.2	3.7	3.6	3.7	3.6
Industries	5.3	5.4	5.0	5.9	2.4	2.4	2.5	2.2
Processed meat	0.0	0.2	0.1	0.3	1.6	1.3	1.4	1.2
Other processed food	10.3	10.3	9.5	11.5	2.1	2.0	1.9	2.0
Petroleum	4.1	4.0	4.0	4.0	4.2	4.2	4.2	4.0
Chemicals	6.9	6.9	6.7	7.2	2.4	2.5	2.7	2.4
Other manufacturing	2.9	2.9	2.6	3.3	1.7	1.8	2.0	1.6
Services	1.5	1.5	1.3	1.8	1.7	1.7	2.0	1.3

Source: own elaboration.

Table 5. Impacts on returns to factors and household income (percentage change from the baseline 2025).

	Returns to factors							Household income			
	Skilled	Semi-skilled	Unskilled	Land	Livestock	Ag Capital	Nag Capital	Urban Dakar	Rural Dakar	Other Urban	Other Rural
DomFin	1.8	1.9	1.7	1.0	1.0	0.9	1.0	1.1	1.1	1.2	1.0
GovDebt	2.1	2.2	1.8	0.9	0.9	0.8	1.0	0.9	1.1	1.3	0.9
ForBond	3.4	3.2	2.0	0.2	0.1	0.2	1.2	1.3	1.2	1.9	0.9
ForInv	1.7	1.8	1.7	1.1	1.1	1.0	1.0	0.8	1.1	1.2	0.9

Source: Own elaboration.

Table 6. Impacts on poverty incidence (percentage point variation from the baseline 2025).

	Observed poverty 2019	Observed population share	Baseline poverty 2025	DomFin	GovDebt	ForBond	ForInv
National	37.8	100	21.5	-0.32	-0.30	-0.32	-0.30
Rural all	53.6	44.9	33.0	-0.28	-0.24	-0.28	-0.24
Urban all	19.8	55.1	8.4	-0.38	-0.36	-0.38	-0.38
Dakar	9.0	14.3	1.7	0.00	0.00	0.00	0.00
Ziguincho	51.1	6.7	28.0	-0.91	-0.91	-0.91	-0.91
Diourbel	43.9	7.7	28.1	-0.20	-0.20	-0.20	-0.20
Saint-Louis	40.1	7.0	25.7	0.00	0.00	0.00	0.00
Tambacounda	61.9	6.0	35.7	-0.37	0.00	-0.37	0.00
Kaolack	41.5	7.4	24.6	-0.36	-0.36	-0.36	-0.36
Thiès	34.1	8.0	18.4	-0.82	-0.82	-0.82	-0.82
Louga	43.4	6.7	25.6	0.00	0.00	0.00	0.00
Fatick	49.2	6.4	32.0	-0.12	0.00	-0.12	-0.12
Kolda	56.6	6.0	32.5	-0.20	-0.20	-0.20	-0.20
Matam	47.7	5.7	22.7	-1.49	-1.49	-1.49	-1.49
Kaffrine	53.0	6.0	24.7	0.00	0.00	0.00	0.00
Kédougou	61.9	6.4	41.0	-0.50	-0.50	-0.50	-0.50
Sédhiou	65.6	5.7	50.0	-0.75	-0.75	-0.75	-0.75

Source: Own elaboration.

Table 7. Impacts on poverty gap (percentage point variation from the baseline 2025).

	Observed poverty 2019	Baseline poverty 2025	DomFin	GovDebt	ForBond	ForInv
National	10.3	4.8	-0.08	-0.07	-0.08	-0.08
Rural all	15.3	7.4	-0.10	-0.09	-0.09	-0.09
Urban all	4.6	1.8	-0.06	-0.05	-0.06	-0.06
Dakar	1.4	0.2	-0.01	-0.01	-0.01	-0.01
Ziguincho	15.5	6.6	-0.16	-0.15	-0.17	-0.16
Diourbel	10.6	6.1	-0.05	-0.03	-0.03	-0.03
Saint-Louis	11.1	5.5	-0.10	-0.09	-0.11	-0.10
Tambacounda-	19.6	7.9	-0.15	-0.14	-0.15	-0.15
Kaolack	11.9	5.9	-0.09	-0.08	-0.10	-0.08
Thiès	7.7	3.6	-0.10	-0.09	-0.10	-0.09
Louga	11.3	5.5	-0.07	-0.06	-0.06	-0.06
Fatick	13.0	6.1	-0.13	-0.12	-0.14	-0.13
Kolda	16.3	7.0	-0.13	-0.12	-0.13	-0.12
Matam	14.6	5.0	-0.08	-0.07	-0.07	-0.08
Kaffrine	16.8	6.4	-0.08	-0.07	-0.06	-0.08
Kédougou	22.1	12.3	-0.12	-0.11	-0.12	-0.12
Sédhiou	21.6	13.2	-0.20	-0.19	-0.21	-0.20

Source: Own elaboration.

Table 8. Impacts on poverty severity (percentage point variation from the baseline 2025).

	Observed poverty 2019	**Baseline poverty 2025**	**DomFin**	**GovDebt**	**ForBond**	**ForInv**
National	3.9	1.6	-0.03	-0.02	-0.03	-0.03
Rural all	5.9	2.4	-0.03	-0.03	-0.03	-0.03
Urban all	1.7	0.6	-0.02	-0.02	-0.02	-0.02
Dakar	0.4	0.0	0.00	0.00	0.00	0.00
Ziguincho	6.5	2.4	-0.06	-0.05	-0.06	-0.06
Diourbel	3.6	1.8	-0.02	-0.01	-0.01	-0.01
Saint-Louis	4.2	1.9	-0.04	-0.03	-0.04	-0.03
Tambacounda-	8.1	2.7	-0.05	-0.05	-0.05	-0.05
Kaolack	4.9	2.2	-0.03	-0.02	-0.03	-0.03
Thiès	2.5	1.0	-0.03	-0.03	-0.03	-0.03
Louga	4.0	1.6	-0.02	-0.02	-0.02	-0.02
Fatick	4.5	1.7	-0.04	-0.04	-0.04	-0.04
Kolda	6.3	2.4	-0.05	-0.04	-0.05	-0.05
Matam	6.1	1.8	-0.03	-0.02	-0.02	-0.03
Kaffrine	7.3	2.1	-0.03	-0.03	-0.03	-0.03
Kédougou	10.6	5.5	-0.05	-0.05	-0.05	-0.05
Sédhiou	9.1	4.7	-0.09	-0.08	-0.09	-0.09

Source: Own elaboration.

Table 9. Impacts on reduction of number of poor from the baseline 2025

	Observed poverty 2019	Baseline poverty 2025	Number of poor lifted out of poverty in 2025			
			Sim1	Sim2	Sim3	Sim4
National	6,032,056	4,424,130	410,909	365,040	528,521	380,017
Rural all	4,548,863	3,420,031	312,447	273,532	403,505	291,351
Urban all	1,483,193	1,004,099	98,463	91,508	125,016	88,666
Dakar	333,068	201,060	10,051	10,051	10,051	10,051
Ziguincho	332,861	290,269	9,639	7,745	18,280	6,285
Diourbel	778,830	427,148	58,218	49,563	71,607	54,019
Saint-Louis	421,404	282,046	17,427	8,831	22,704	8,831
Tambacounda	511,712	464,607	13,612	13,612	17,450	13,612
Kaolack	472,237	371,297	20,870	20,870	35,974	20,870
Thiès	708,665	382,455	90,492	86,461	138,157	86,461
Louga	442,068	291,402	28,454	19,826	28,454	28,454
Fatick	421,486	298,166	56,193	56,193	64,874	56,193
Kolda	443,689	355,607	41,070	34,601	49,002	36,569
Matam	330,423	303,169	12,560	11,176	12,560	12,560
Kaffrine	366,506	358,031	27,091	20,880	28,443	20,880
Kédougou	112,279	107,483	5,024	5,024	5,184	5,024
Sédhiou	356,827	291,389	20,208	20,208	25,783	20,208

Source: Own elaboration.

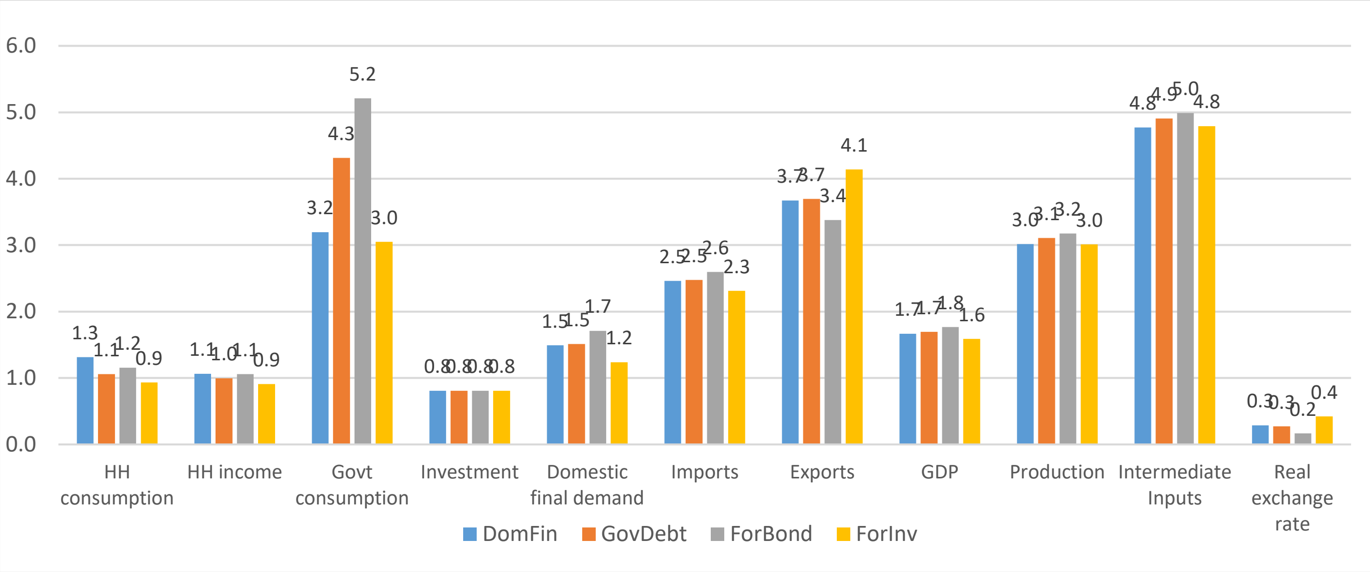
Table 10. Impacts on CO_2 emissions per value added by sectors (percentage change from the base 2025)

	Sectoral share of emission in baseline 2025	Emission per VA by scenarios (percentage change from base 2025)			
		DomFin	GovDebt	ForBond	ForInv
Marginal Farms	0.02	0.56	0.41	0.32	0.54
Marketed Farms	0.01	-0.22	-0.49	-0.62	-0.31
Mining	0.12	-0.08	-0.11	-0.31	0.18
Processed food	0.04	-1.15	-1.24	-1.14	-1.37
Chemicals	0.06	-1.13	-1.12	-1.15	-1.08
Other Manufacturing	0.08	-1.24	-1.22	-1.40	-0.97
Electricity	0.21	-15.10	-15.10	-15.10	-15.11
Construction	0.24	0.05	0.05	0.05	0.04
Transports	0.19	0.08	0.04	0.05	0.03
Other services	0.03	-0.23	-0.22	-0.20	-0.25
Total Activities	0.80	1.65	1.53	1.43	1.67
Households	0.20	0.66	0.30	0.47	0.06

Source: Own elaboration.

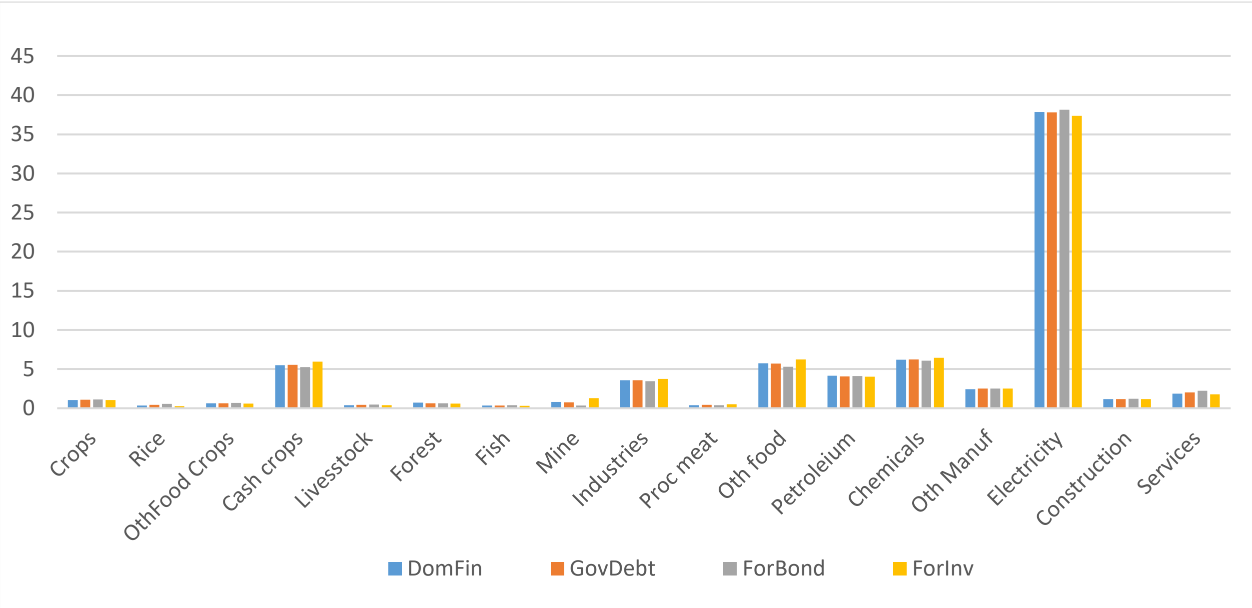
FIGURES

Figure 4. Impacts on macro indicators (percentage change from the baseline 2025).



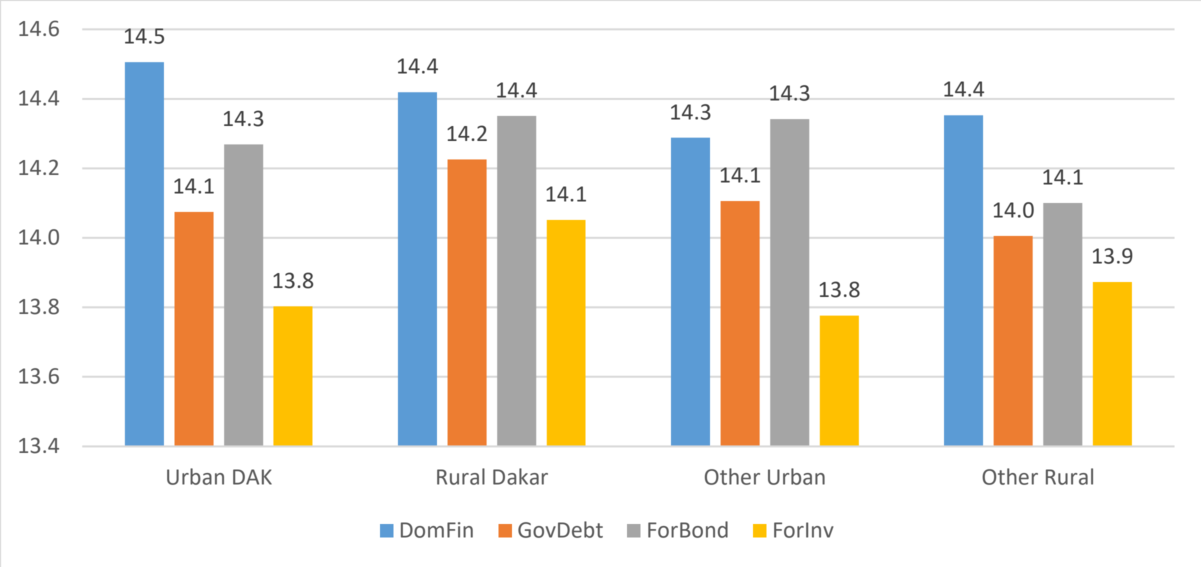
Source: Own elaboration.

Figure 5. Impacts on sectoral production (percentage change from the baseline 2025).



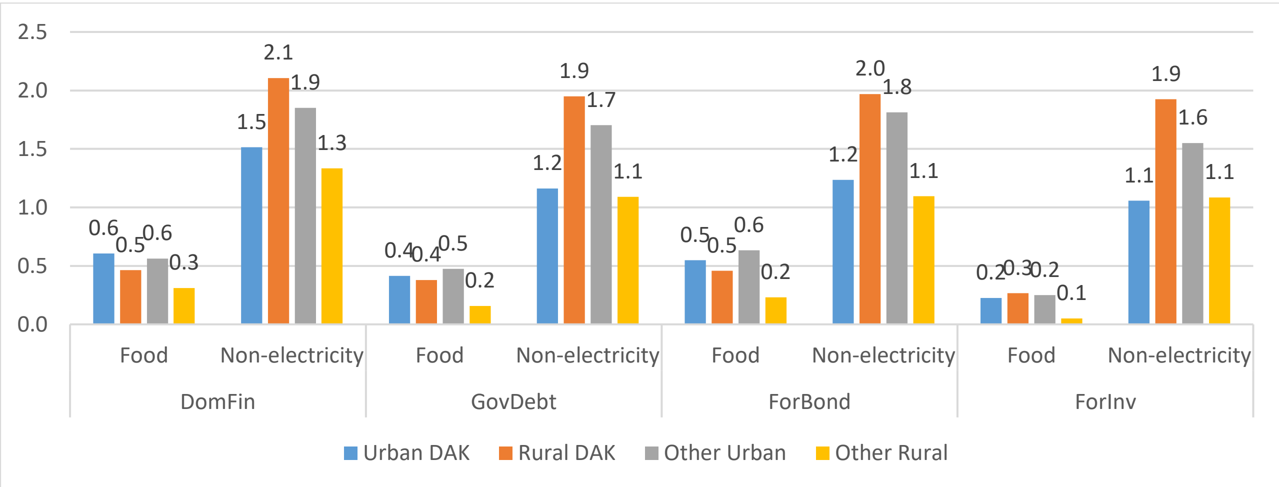
Source: Own elaboration.

Figure 6. Impacts on household electricity consumption (percentage change from the baseline 2025).



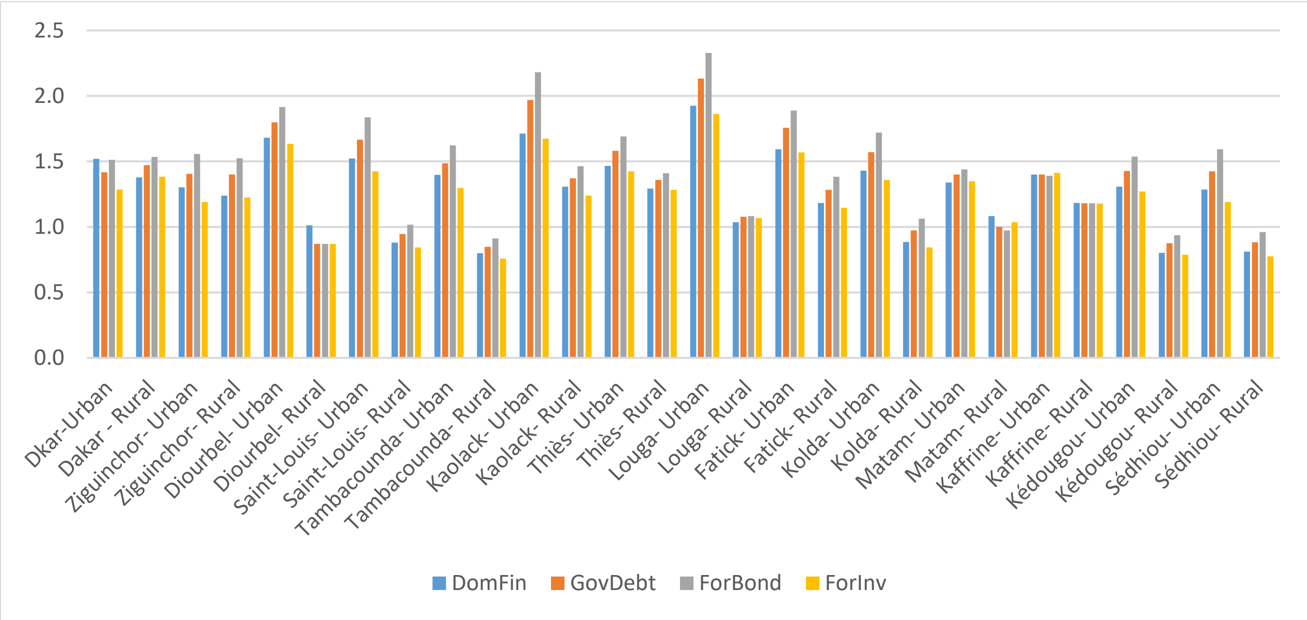
Source: Own elaboration.

Figure 7. Impacts on household non-electricity consumption (percentage change from the baseline 2025).



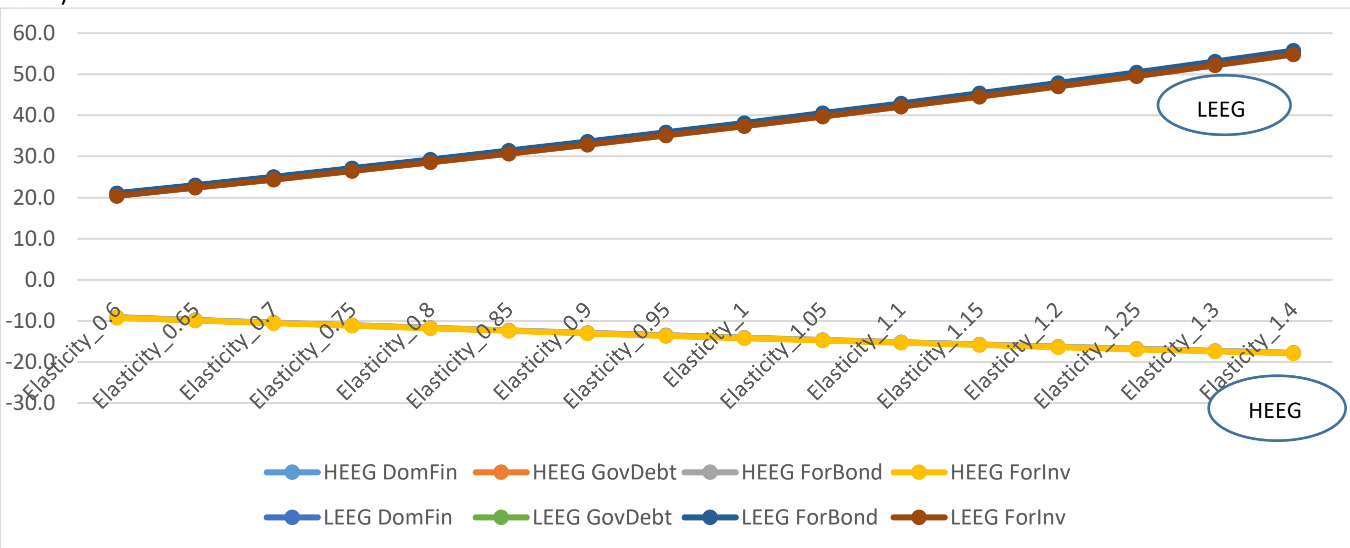
Source: Own elaboration.

Figure 8. Impacts on household welfare (percentage change from the baseline 2025).



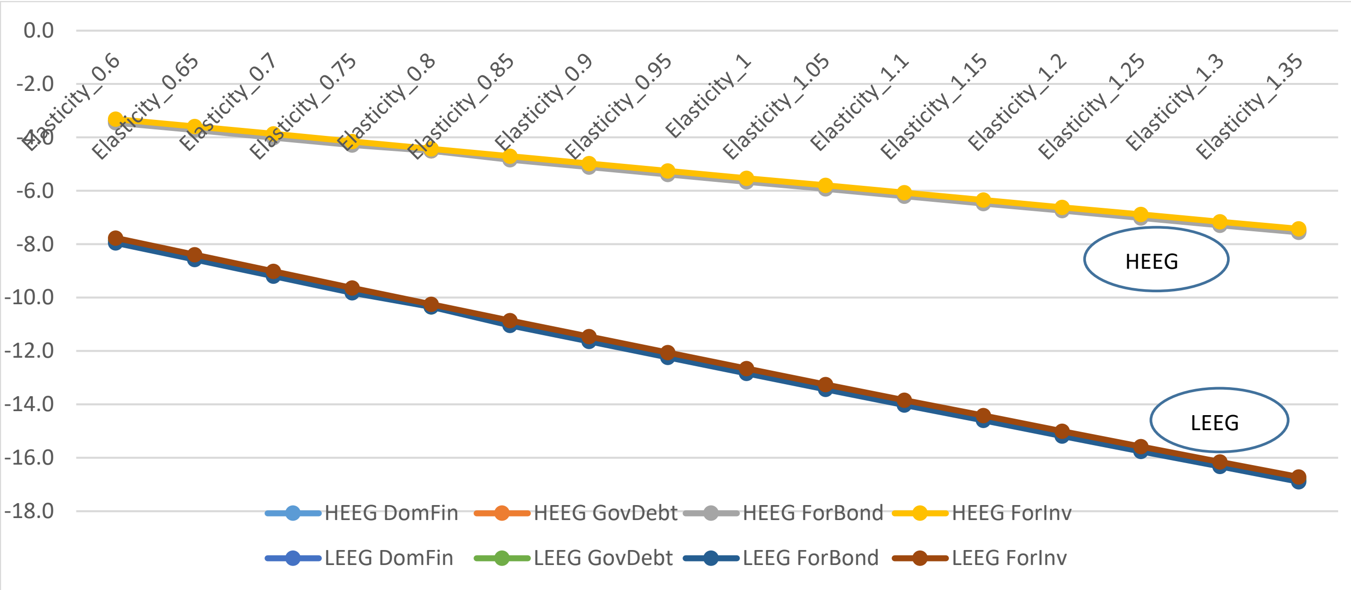
Source: Own elaboration.

Figure 9. Impacts on fossil and non-fossil-based generation (percentage change from the baseline 2025).



Source: own elaboration.

Figure 10. Impacts on prices fossil and non-fossil-based electricity (percentage change from the baseline 2025).



Source: Own elaboration.