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► Just Transition Assessment Model Côte d'Ivoire





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Cover photo

ILO

Presentation of the institutions that contributed to this study

The International Labor Organization (ILO) is a specialized agency of the United Nations based in Geneva, Switzerland. Created in 1919, the ILO brings together governments, employers, and workers from 187 member states to promote social justice and human rights at work. The organization is a pioneer in integrating the social dimension of sustainability through the concept of Just Transition, which aims to reconcile climate action, decent job creation, and economic inclusion.

SINTEF, or tiftelsen for industriell og teknisk forskning, which means "Foundation for Scientific and Industrial Research," is an independent, non-profit research institute based in Trondheim, Norway. SINTEF is one of the largest applied research institutes in Europe, recognized for its interdisciplinary work linking science, engineering, and technological innovation. It develops concrete solutions to meet the major challenges of sustainability and competitiveness. The institute works to promote a just transition through research into clean technologies, energy efficiency, sustainable resource management, and the creation of green jobs in industrial sectors.

University NANGUI ABROGOUA and Partners, based in Abidjan, is science-focused and active on ecology: it runs research and training in biodiversity, water/waste management and sustainable agro-systems, and partners with local actors on climate-adaptation and urban-ecology projects—feeding Côte d'Ivoire's just-transition agenda.

► List of abbreviations

Abbreviations	Signification
AFAT	Agriculture, Foresterie et Autres Utilisations des Terres
BUR	Biennial Update Report (Rapport Biennal Actualisé)
CES	Constant Elasticity of Substitution
CGM	Computable General Equilibrium Models (Modèles d'Équilibre Général Calculable)
CO₂	Dioxyde de carbone
EDGAR	Emissions Database for Global Atmospheric Research
EPCI	Engineering, Procurement, Construction, Installation
GAIN	Green Jobs Assessment Institutions Network
GDP	Gross Domestic Product (Produit Intérieur Brut)
GHG	Greenhouse Gas (Gaz à Effet de Serre)
GJAM	Green Jobs Assessment Model
GWh	Gigawatt-heure
ILO	International Labour Organization (Organisation Internationale du Travail)
IMF	International Monetary Fund (Fonds Monétaire International)
INFORGE	Interindustry Forecasting Germany (modèle économétrique)
INFORUM	Interindustry Forecasting Project at the University of Maryland
IPCC	Intergovernmental Panel on Climate Change
IO	Input-Output (tableau entrées-sorties)
IOT	Input-Output Table
IRENA	International Renewable Energy Agency
LCOE	Levelized Cost of Energy (Coût actualisé de l'énergie)
LEDS	Low Emission Development Strategy (Stratégie de Développement à Faibles Émissions)
LULUCF	Land Use, Land-Use Change and Forestry (Utilisation des Terres, Changement d'Affectation des Terres et Foresterie)
MEIO	Macro-Econometric Input-Output (modèle macro-économétrique entrées-sorties)
Mt CO₂-eq	Méga-tonne équivalent CO ₂
NDC	Nationally Determined Contribution (Contribution Déterminée au Niveau National)
NPISH	Non-Profit Institutions Serving Households
OECD	Organisation for Economic Co-operation and Development
PANER	Plan d'Actions National des Énergies Renouvelables
PNIA	Programme National d'Investissement Agricole
PV	Photovoltaïque
RSA	Rapid Situational Analysis (Analyse Situationnelle Rapide)
SAM	Social Accounting Matrix (Matrice de Comptabilité Sociale)
SUT	Supply and Use Table (Tableau des Ressources et des Emplois)
UNDP	United Nations Development Programme (Programme des Nations Unies pour le Développement)
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
UNSD	United Nations Statistics Division
VA	Valeur Ajoutée

► List of figures

Number	Title	Pages
Figure 1	Trends in real GDP and its annual growth rate	11
Figure 2	Evolution of GDP per capita over the last five years in Côte d'Ivoire	11
Figure 3	Sectoral contribution to supply-side growth (in %)	12
Figure 4	Employment by industry in 2019	12
Figure 5	Change in sectoral contributions to employment, 2015-2019	13
Figure 6	Breakdown of total GHG emissions by sector from 1990 to 2020	13
Figure 7	Annual changes in Value Added, employment, and GHG emissions in the solar PV scenario compared to baseline	19
Figure 8	Relative difference in employment to the baseline by industry (excluding solar)	20
Figure 9	Main trends PNIA scenario, percentage difference with respect to baseline	21
Figure 10	Absolute increase in employment PNIA scenario 2030 and 2035	21
Figure 11	Changes in Value-added PNIA scenario 2030-2035	22
Figure 12	Changes in GHG emissions PNIA scenario 2030 and 2035	24
Figure 13	Overview of employment effects by gender and industry	25
Figure 14	Overview of employment effects by skill level and industry	25
Figure 15	Figure 14 – Simplified illustration of a supply table (left) and a use table (right), extended with employment and GHG emissions data per industry.	30
Figure 16	Baseline scenario: Macroeconomic trends	37

► List of tables

Number	Title	Pages
Table 1	Expected electricity production according to PANER	17
Table 2	Distribution of Investments for Utility Scale solar PV	17
Table 3	Outcomes of the Solar PV scenario, compared to baseline	19
Table 4	Input distribution Solar PV	32
Table 5	List of SUT 47 products	33
Table 6	List of SUT 47 industries	33
Table 7	List of final demand categories	34
Table 8	Value added categories	34
Table 9	All indicators available in labour extensions, and the distribution of employment in 2018	34
Table 10	All indicators available in GHG emissions extensions, and the distribution of emissions in 2018 by activity and by gas	34
Table 11	Correspondence between emissions from the original activities in the EDGAR database and the SUT industries	35
Table 12	Income elasticities for broad consumption categories for Côte d'Ivoire from the USDA international food comparison programme	37



► Table of Contents

1.	Executive summary	9
2.	Background	10
3.	Current state of the Economy, Employment and Emissions	10
3.1	Economic performance	10
3.2	Employment by industry	11
3.3	GHG emissions by industry	13
4.	Policy scenarios and scenario assumptions	14
4.1	Just Transition assessment modelling	14
4.2	Green electricity scenario: Increasing solar PV capacity and electricity generation. . .	17
4.3	Green agriculture scenario: The National Agricultural Investment Programme	20
4.4	Comparing green scenarios: effects on employment by gender and skill level	24
5.	Policy implications and analysis	27
6.	References	28
A.	Annex: Method and data	29
A.1	Background and modelling philosophy.	29
A.2	Existing economic scenario models in Côte d'Ivoire	29
A.3	Using supply-and-use tables for policy analysis.	29
A.4	Data for the Just Transition Assessment Model	32
	A.4.1 Overview over data sources for the Just Transition Assessment Model	32
	A.4.2 The Côte d'Ivoire supply and use table	32
	A.4.3 Measuring impacts: Labour extensions.	34
	A.4.4 Measuring impacts: GHG emission extensions	34
A.5	Baseline development	36



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► 1. Executive summary

Côte d'Ivoire's national development objective is to maintain a growth rate of 7% to achieve an economic transformation by 2030. A focus is set on strategic growth sectors in agriculture and agro-industry, energy and industrialization to foster growth and create value added.

While it is clear that Côte d'Ivoire's primary target is economic growth, the strategic sectors promoted by the Government heavily depend on nature and a stable climate. This so-called natural capital is worth an estimated 45% of the national economy, much higher than the human and economic capital, and thereby the basis for economic growth. This means that high long-term growth rates of 7% can only be achieved if nature and its assets - the soils, forests, fish and minerals - are managed sustainably and that so-called green investments are made to exploit the natural capital sustainably, such as renewable energy, cocoa, agriculture, and tourism. Notably, agriculture and cocoa are major growth sectors accounting for significant shares of GDP and employment and some 40% of export revenues. It is this natural capital that is the asset to Côte d'Ivoire, which, combined with investments into its human capital - generates growth and employment and when depleted or destroyed, will severely hinder economic development and social wellbeing.

To better understand the link between jobs and development on the one hand and nature, biodiversity and climate change on the other, the report assesses the job and economic growth impacts of Ivory Coasts' green and climate policies. Notably, the report will assess the impact of the National Determined Contributions (NDC), the Renewable Energy Action Plan (PANER), and the National Agricultural Investment Program (PNIA 2) on the national growth and development objective.

Specifically, two scenarios - a Green Energy and Green Agriculture Scenario - is developed and compared to a business-as-usual scenario.

The Green Energy Scenario takes into account the climate and energy policies and its focus on solar power to exploit Ivory Coast's high solar potential and low cost advantage. The target is to reach 100% electricity access of the population and increase the share of renewables on the total electricity mix up to 42% by 2030.

The green agriculture scenario is based on the National Agriculture Investment Program (PNIA 2) proposes a vision of sustainable, competitive agriculture in Côte d'Ivoire, creating wealth that is equitably shared. The aim is to stimulate sustainable growth, to halve poverty and achieve "zero hunger" by 2025. Notably, a competitive agro-sylvo-pastoral and fisheries sector is targeted to create value-added and wealth that is equitably shared. It covers the sub-sectors of agriculture, livestock, fisheries, aquaculture and environmental management to guarantee rural development and inclusive growth.

In terms of results, both scenarios show strong and positive gains in terms of employment and economic growth as compared to the business-as-usual scenario. Aggregate results imply an increase of more than 750,000 new jobs when compared to the business-as-usual scenario with a 5 percentage point increase of GDP by 2030.

The Green Energy Scenario clearly shows the interlinkages between the economy and Côte d'Ivoire's natural capital and climate. If Ivory Coast is to scale up investment into solar power to achieve the renewable energy target, outcomes are positive in terms of economic gains, employment, and reduced GHG emissions simultaneously. Economic growth and employment gains are up to 1.2 % higher as compared to baseline, increasing electricity access while decreasing GHG emissions of the whole economy by some 0.4%. In absolute terms, compared to business as usual, the solar PV scenario results in additional 140,000 new jobs by 2030, and lead to a decrease of -122 Mt CO₂-eq.

Regarding the Green Agricultural Scenario - in addition to direct job growth in the agriculture and agro-industries, positive impacts in almost all other sectors of the economy are shown. Notably, in commerce, transport and supplying sectors, an increase in value added and employment results from the supply chain and income effects.

Finally, results for GHG emissions are mixed. In aggregate, emissions are higher than the baseline scenario because of higher economic activity. Even though there are higher GHG emissions, they are lower than in the business-as-usual scenario and are the result of economic development from a low level. Growth is necessary to reduce poverty, improve agricultural productivity, and put the whole economy on a higher growth path.

While the job creation effect is highly positive in the aggregate, it is important to identify where and which jobs, for which gender and age group will be gained, and which jobs will be lost. Anticipating where and what type of jobs will be created and where jobs will be lost allows for the design of just transition policies to maximise the benefits of job creation and ensure negative impacts from job losses are countered.

Above all, to enable positive growth effects and a restructuring of the economy towards sustainability requires the skilling, re-skilling and training of workers away from declining towards emerging industries. As there is a relative loss in jobs in the extractive industries, those jobs need to be re-skilled and transitioned. Emerging growth sectors with significant demand for new jobs are found in renewable energy installation and maintenance and supplying sectors such as commerce, metallurgy, electronics, informatics, electric machinery, finance and assurance. These industries are part of the investment value chain required for the installation of solar PV plants. While these jobs tend to be male-dominated, a gender equality policy may be required to increase women's participation by closing the gender pay gaps, ensuring family compatibility and dedicating training for women. For older workers in declining industries and declining fossil fuel regions, social protection schemes and early retirement policies may be required. In addition, to cater for regions entirely dependent on fossil fuels for their income and direct and indirect jobs in restaurants, commerce and retail, Ivory Coast must implement regional structural support programs, including re-training and relocation options for communities affected negatively by the transition.

► 2. Background

The preamble to the Paris Agreement on Climate Change, adopted in 2015, emphasizes the close links between climate action, sustainable development and just transition, with Parties to the Agreement “taking into account the imperatives of just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities”. Ideally, any NDC process should be informed by an assessment of employment impacts - both positive and negative - as well as an indication of the measures that will be taken to ensure a just transition for workers, maximizing job creation while protecting those who may be affected by restructuring.

In this context, the International Labor Organization (ILO) has developed a series of tools to measure how green and climate policies affect job creation, for women and young people, income distribution, skills development and economic growth. More specifically, two complementary tools will support the development of evidence-based NDC (Nationally Determined Contribution) policies to ensure a just transition in Côte d’Ivoire:

- A mainly qualitative Rapid Situational Analysis (RSA): this reviews national social, economic, labor market, gender and environmental statistics, information and policies. It analyzes the links between employment, the economy and the environment/climate, and the policies that govern all three spheres. Based on the analysis, it proposes key sectors with the highest potential and need for just transition and relevant policies to be considered in NDCs.
- A Just Transition Assessment Model (JTAM): a macro-economic model - fully aligned with the System of National Accounts - that links the environment and the labor market coherently to economic sectors. It can quantify the environmental, economic, employment and social

impacts of NDC policies at a sectoral level. Key indicators of interest to the government can be assessed, including: impacts on GDP, CO₂ emissions, direct and indirect employment, skills, gender, youth, income distribution, poverty, informality and others. In this way, it enables the quantitative analysis of alternative policy scenarios to identify policies that maximize employment gains and minimize losses, while ensuring the protection of those negatively affected.

The results of the assessment, and its connected multi-stakeholder dialogue process at country level, will guide the development of evidence-based NDC policies and support just transition. The Climate Change Department has requested support to conduct an RSA and create a JTAM for Côte d’Ivoire, to reflect the employment and just transition objectives in the revised NDC.

The work carried out as part of this study will contribute directly to the development of a national Just Transition Assessment Model for Côte d’Ivoire and ensure that employment and just transition policies are integrated into the revised NDC and climate-related sector implementation plans and strategies (such as the Low Greenhouse Gas Emissions Development Strategy - LEDS).

This report is structured around three main points: (i) the presentation of the climate policy scenarios provided for in Côte d’Ivoire’s NDC framework, (ii) the Just transition evaluation methodology and analysis data used (iii) the results of the NDC climate scenario simulations.

► 3. Current state of the Economy, Employment and Emissions

Côte d'Ivoire's recent economic dynamics and current social and environmental profile present contrasts of both good economic performance and poor social and environmental performance. This section examines recent economic developments and the current state of social and environmental indicators in Côte d'Ivoire.

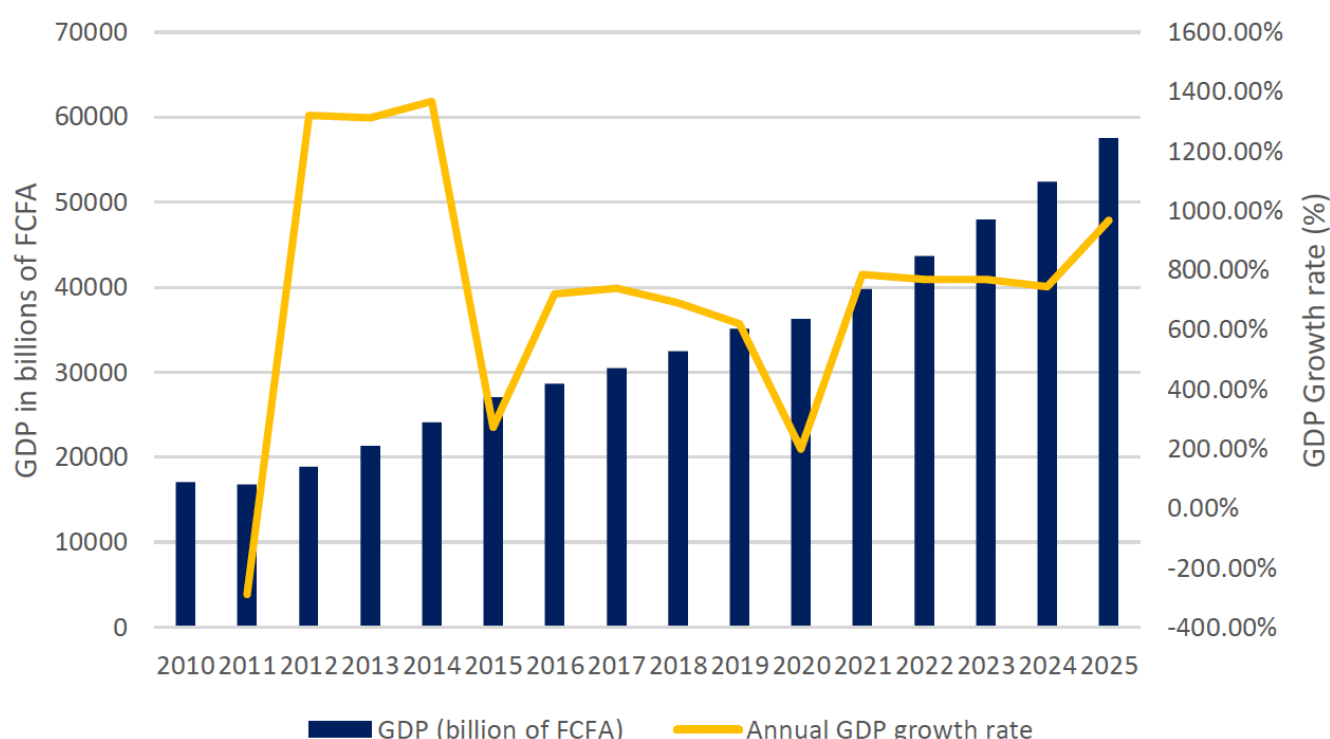
3.1 Economic performance

After a decade of political crisis, Côte d'Ivoire has been enjoying strong growth since 2012. Its average growth rate

between 2012 and 2023 is estimated at 7.8%, which makes the Ivorian economy one of the most dynamic in Sub-Saharan Africa (DGE, 2023). This sustained pace of growth is partly due to the implementation of vast projects to revive and rebuild road and basic socio-economic infrastructures.

The Ivorian economy is also characterized by a strong capacity for resilience, given the rapid recovery of its economy in 2021 with a growth rate of 7%, after a contraction in economic activity to 2% in 2020 following the Covid-19 health crisis (DGE, 2023) (Figure 1).

► Figure 1 – Trends in real GDP and its annual growth rate¹



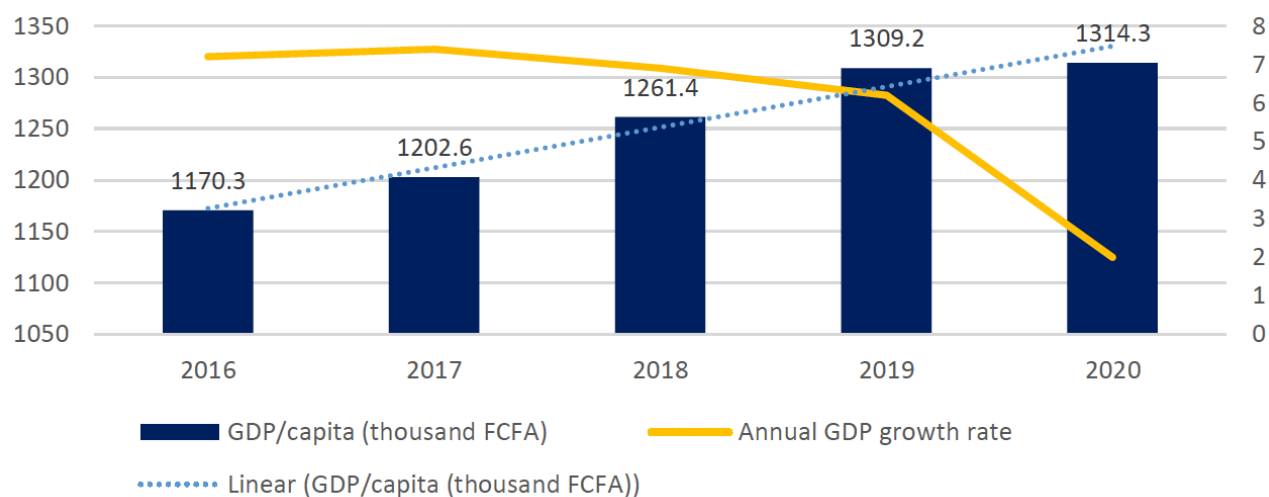
Source: Authors based on data from Direction Générale de l'Economie (MEF/DGE, 2023).

Sustained economic growth in GDP over the past decade has been accompanied by a gradual improvement in annual per capita income, which in 2020 will stand at 1,314 million FCFA (US \$ 2,283) (National Development Plan, 2021-2025) (Ministère du Plan et du Développement, 2021). Despite this

clear progress, Côte d'Ivoire remains in the lower-middle category with a poverty rate of 39.4% in 2020. Côte d'Ivoire aspires to reach the upper bracket of middle-income countries. Figure 2 presents the dynamics of GDP per capita over the last five years in Côte d'Ivoire.

1. Data for 2024 and 2025 are DGE (Direction Générale de l'Economie) projections

► **Figure 2 – Evolution of GDP per capita over the last five years in Côte d'Ivoire**

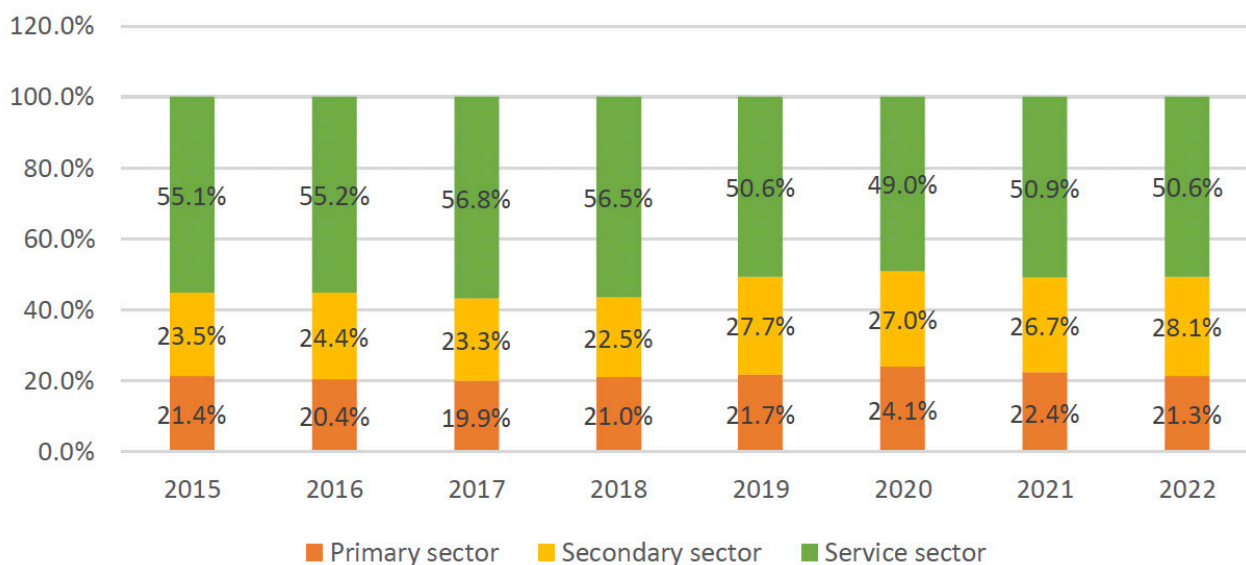


Source: MEF/DGE/INS, 2023

Analysis of sectoral contributions shows that Côte d'Ivoire growth momentum has been driven primarily by the secondary and tertiary sectors. The main growth driver has been the service sector, with an average contribution of 50% to growth over the 2015-2021 period (Figure 3). The expansion of financial services, ICT, transport, and trade has

played a major role in the recent economic performance of the Ivorian economy. The secondary sector was the second largest contributor from 2015 to 2022, with an average contribution to growth of around 27%, driven by the expansion of the construction and public works sector and major public and private investment in infrastructure.

► **Figure 3 – Sectoral contribution to supply-side growth (in %)**



Source: Authors based on data from Direction Générale de l'Economie (MEF/DGE, 2023).

To a lesser extent, the primary sector made a positive contribution over the period (21% on average), reflecting improved

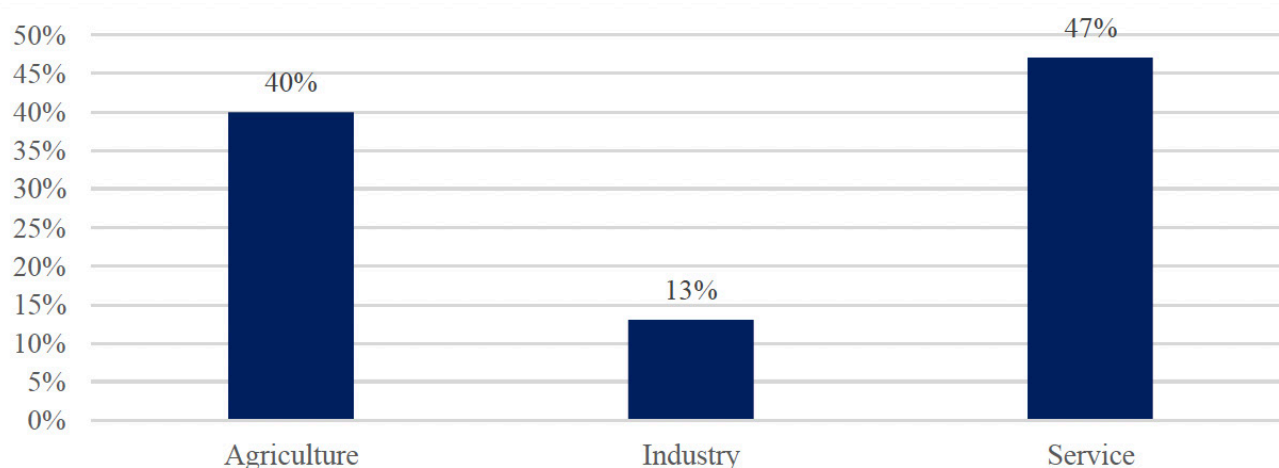
productivity in the sector and relatively favorable agro-climatic and trading conditions.

3.2 Employment by industry

The employed population on Ivory Coast represents more than half (62.9%) of the working-age population (around 8 million people). The structure of employment by age shows that the employment rate is higher among adults than among 15-24 year-olds. The employment rate for 15-24 year-olds is 41% compared with 65% for those aged between 25 and 35, and around 75% for adults over 35. The employment rate is higher for men than for women. It stands at 70.9% for men versus 54.7% for women (ERI-ESI, 2017-2018)(INS, 2021).

Examination of employment by industry for 2019 (Figure 4) reveals significant differences in employment contribution between the three main sectors of the economy. The service sector is the largest provider of jobs, accounting for almost half of total employment (47%), followed by the agricultural sector, which accounts for 40% of the employed population, and finally the industrial sector, which contributes just 13% of total employment.

► Figure 4 – Employment by industry in 2019

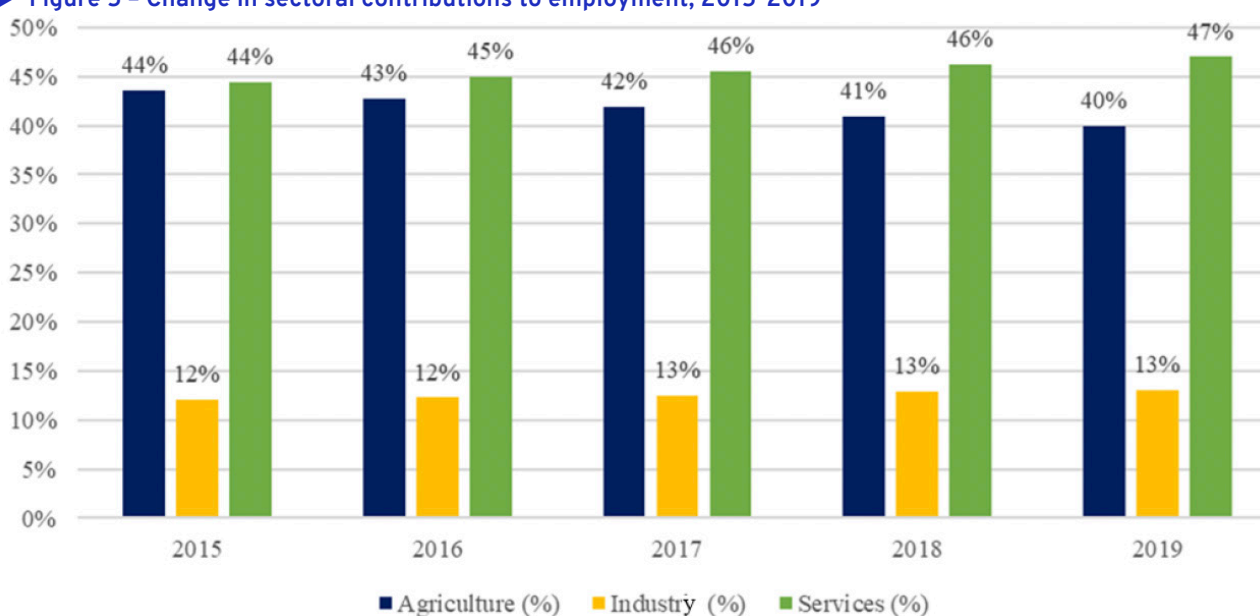


Source: ILOSTAT, 2021

Analysis of sectoral employment trends from 2015 to 2019 reveals a decline in employment in the agricultural sector in favor of services, while the share of industrial employment in total employment has remained stable over the period. Indeed, the share of the primary sector has fallen from 44% in 2015 to 40% in 2019, suggesting a migration of workers

towards services (mainly the informal tertiary sector), whose share has grown over the years to 47%. This reallocation employment has not benefited the industrial sector, whose contribution to employment has stagnated at around 13% (Figure 5).

► Figure 5 – Change in sectoral contributions to employment, 2015-2019



Source: ILOSTAT, 2021

3.3 GHG emissions by industry

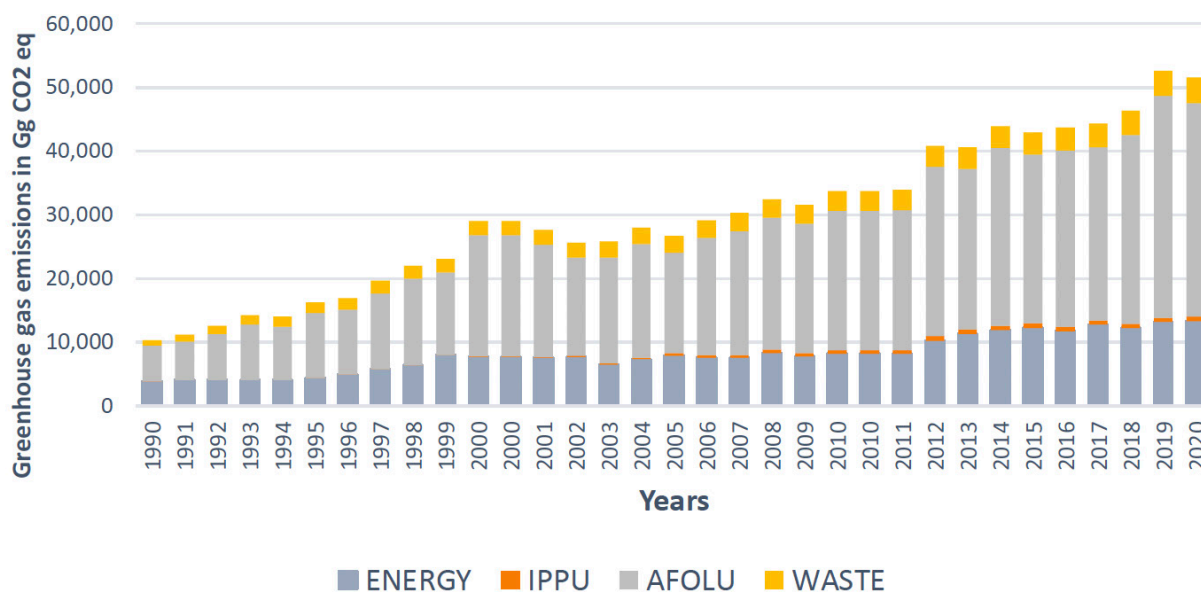
The results of the inventories show that Côte d'Ivoire, which sequestered carbon estimated at -63,748.351 Gg eq. CO₂ in 1990 has reduced its carbon sequestration estimated at -16,762.926 Gg eq. CO₂ in 2020, a reduction of 73.7% compared with the reference year (1990).

Total net emissions, estimated at 51,535.157 Gg eq. CO₂ in 2020, are five (05) times higher than in the 1990 reference year. This shift from sink to source status is explained by the combined effects of deforestation (mainly conversion of forests to cropland), forest degradation and other land uses (due to the collection of commercial roundwood and energy wood), and the increase in GHG emissions, especially in the energy and agriculture sectors.

The leading sector in terms of emissions/absorptions in Côte d'Ivoire is the Agriculture, Forestry and Other Land Use (AFAT) sector, which accounts for 65.19% of total net emissions in 2020, followed by the Energy sector with 25.77% of emissions, then the Waste sector (7.69%) and, lastly, the PIUP sector with 1.35%.

Figure 6 shows the breakdown of total GHG emissions by sector from 1990 to 2020.

► **Figure 6 – Breakdown of total GHG emissions by sector from 1990 to 2020**



Source: Biennial update reports (BUR 2, 2023)

► 4. Policy scenarios and scenario assumptions

4.1 Just Transition assessment modelling

JTAMCotedIvoire is a macro-econometric input-output (MEIO) model, based on data from the National Agency of Statistics and Demography. The main data sources are the System of National Accounts, supply-and-use tables (INS, 2018a), the GHG inventory (BUR 2, 2023), and household and labour force surveys (INS, 2018b). JTAMCotedIvoire is following the same philosophy and modelling approach as taken for MEIONorway (Aponte et al., 2021; Wiebe et al., 2022) and the models in several other Green Jobs Assessment Reports², e.g., Nigeria, Zimbabwe, Turkey, Burkina Faso, or Ghana³. Section A gives a short background on the modelling philosophy, Section 1a)i)(1)(a)i)1.A.2 gives an overview on existing economic models in Ivory Coast, Section 1a)i)(1)(a)i)1.A.3 a description of how to use this type of models for policy analysis and Section 1a)i)(1)(a)i)1.A.4 a detailed description of the data used.

The Just Transition Assessment Models (JTAMs) quantify impacts of policies on:

- The economy. Gross value added corresponds to the GDP by industry, giving insights on the effects of climate policies on national GDP growth, and on the growth or decrease of each industry's economic activity
- Greenhouse gas emissions. Besides direct changes due to, for example, a decrease of coal electricity, it also considers

the net changes in emissions, including increased emissions from infrastructure investments, and from increased or decreased economic activities in other industries.

- Employment. The model gives insights into the potential increase or decrease of the demand for workers in different industries. By including information on the structure of workers in each industry, per gender, skill level, and formality status, it can measure how the demand for skills will change in the economy, and how it can affect workers in disadvantaged groups.

The results of the green scenarios are always assessed relative to a reference (baseline) scenario: This serves as a baseline to which the development in the green scenario can be compared. Here, we assume for the baseline that the economy grows (as specified in more detail in Section A.5, but that the general structure of the economy does not change: industries are continuing to produce with the same production technology and the import shares of products remains stable.

It is important to note that JTAMs are not economic forecasting models. Rather, these models are a tool to inform about possible effects of "what-if" scenarios on emissions and labour demand by industries, given that the remaining structure of the economy remains as is. The results show how changes in individual economic activities influence the economic structure and reflect on direct, indirect, and induced effects.

2. The Green Job Assessment Model (GJAM), now renamed the Just Transition Assessment Model (JTAM), reflects a major conceptual shift. This change in name marks the shift from an approach focused solely on assessing green jobs to a more holistic perspective, integrating them into a just transition dynamic. This encompasses the social, economic and environmental dimensions of climate change policies in a cross-cutting manner.

3. The reports are available for download at <http://www.ilo.org/gain>.

► How do Just Transition Assessment Models work?

Just Transition Assessment Models are built to answer one main question:
How do climate and other green policies affect workers?

Here is how it works:

First, policies questions are translated into scenarios, describing these policies in values such as:

- Which are the industries directly affected? For example, electricity generation industries when shifting from coal to solar and wind electricity
- How fast and by how much do green industries grow? For example, how does the electricity mix change year by year, by increasing green electricity and decreasing in coal shares?
- What are the investments needed for this transition? Investments include, for example, goods, services, research, and training.

Next, these scenarios are implemented in the model:

- A baseline scenario for economic growth is built using macro-econometric parameters for economic and population growth
- New green industries are added to the supply-and-use table
- Annual changes in the market shares of green and traditional industries supplying products according to green industries' growth
- Annual investments in green industries distributed in products as additional investments to the economy or replacing investments in traditional (such as coal) industries.

Finally, the model quantifies direct impacts on the industries affected, and how these changes affect the demand for goods and services from other industries (and how increase or decrease of economic output from these other industries affect the demand from other industries, and so on).

The results of the JTAM model, then, comprise all (direct and indirect) impacts of the modelled policies on the economic output of every industry in the national economy, and how these affect workers and greenhouse gas emissions in each industry.

4.2 Green electricity scenario: Increasing solar PV capacity and electricity generation

This scenario follows both the NDC plan of Ivory Coast and the Plan d'Actions National des Energies Renouvelables (PANER) (Ministère de l'Environnement et du Développement Durable, 2022; Ministère du Pétrole et de l'Energie (MPE), 2016). Specifically, the scenario focuses on the action **M10 electricity production: Increase solar PV production**

capacity to 490MW in 2030. The PANER also considers the ambitions of the country to reach 100% population electricity access and increase the share of renewables on the total electricity mix up to 42% in 2030. Table 1 shows the expected electricity production by source and the total production expected in 2030.

► **Table 1 – Expected electricity production according to PANER**

Electricity Source	2025	2030		
	Production GWh	Share of renewables	Production GWh	Share of renewables
Hydro (Medium and Big plants)	6380	60 %	6380	56 %
Small Hydro plants	608	6 %	685	6 %
Solar PV	60	1 %	672	5,95 %
Biomass	3537	33 %	3556	31 %
Total Renewables	10585	100 %	11293	100 %
Non renewable electricity production	N/A	N/A	15595	
Total electricity Production	N/A	N/A	26888	

Source: GIZ (Invest for Jobs et al., 2021)

We calculated the necessary investments to achieve the NDC and PANER plans by using the total installed costs breakdown of utility-scale solar PV (IRENA, 2022) and matched those expenses to the products on the Côte d'Ivoire SUT as shown in Table 2.

► **Table 2 – Distribution of Investments for Utility-Scale Solar PV**

Product	Share
Metallurgical Products; Metal Works	6,61 %
Electronic and Computer Products	0,93 %
Electrical Equipment and Materials	56,69 %
Machinery and Equipment N.E.C.	2,12 %
Repair and Installation of Machinery and Equipment	13,94 %
Financial and Insurance Services	14,50 %
Specialised, Scientific and Technical Activities	1,57 %
Public Administration Services	2,45 %
Support and Office Services Activities	1,17 %

For the value of investments needed, we extrapolated the value of the first large solar PV plant (Mammoser, 2023) in Ivory Coast and distributed the total value evenly from 2024 to 2027. Finally, we assume that the additional electricity production brought by the solar investments contributes to increasing the population's access to electricity. According to the International Energy Agency⁴, 59% of the total electricity produced in Côte d'Ivoire is consumed by households and, consequently, we assume an increase in households' consumption of electricity equivalent to 59% of solar PV electricity production.

Recall, in the Green Scenario, Ivory Coast is assumed to invest into solar power. Outcomes are positive in terms of economic gains, employment, and reduced GHG emissions (Table 3 and Figure 7). Economic and employment gains from solar PV investments and from the growth of green electricity industries is attained with a significant decrease in annual GHG emissions.



► **Figure 7 – Annual changes in Value Added, employment, and GHG emissions in the solar PV scenario compared to baseline**



Table 3 summarizes the changes in annual value added, employment, and GHG emissions between the baseline scenario and the solar PV scenario. As mentioned previously, the outcomes of the solar PV scenario should always be compared to the baseline scenario, since the JTAM does not attempt to forecast what happens in the economy, only measures a “what if” situation comparing what are the effects of investments in renewable electricity compared to the business-as-usual scenario. The outcomes illustrated in

Table 3 are due to a combination of impacts of investments in solar PV, and long-term structural changes in the electricity industry and in the demand for goods and services from other industries to operate and maintain these new power plants. Compared to the baseline scenario, the solar PV scenario results in additional 521431,17 million (in 2018 constant prices) for the year 2030, over 135026 extra jobs by 2030, and lead to a decrease of -122 Mt CO₂-eq, 0,3% lower annual emissions compared to the reference scenario.

► **Table 3 – Outcomes of the Solar PV scenario, compared to baseline**

	Value Added		Employment		GHG Emissions	
	Local currency	% difference	Jobs	% difference	Mt CO ₂ -eq	% difference
2024	267329,90	0,54 %	61153,91	0,47 %	141,226	0,49 %
2025	376552,18	0,73 %	86545,15	0,65 %	201,444	0,68 %
2026	538728,97	1,01 %	130907,69	0,94 %	267,573	0,87 %
2027	609304,20	1,10 %	146603,96	1,02 %	253,374	0,79 %
2028	521250,08	0,91 %	135410,79	0,92 %	135,626	0,41 %
2029	513999,38	0,87 %	133864,03	0,88 %	16,313	0,05 %
2030	521431,17	0,86 %	135026,88	0,86 %	-122,667	-0,35 %
2031	532902,60	0,85 %	138090,16	0,86 %	-128,138	-0,36 %
2032	545803,01	0,85 %	141448,46	0,86 %	-132,787	-0,36 %
2033	559241,72	0,85 %	144926,37	0,86 %	-137,357	-0,36 %
2034	572971,48	0,85 %	148473,21	0,85 %	-142,046	-0,37 %
2035	586921,40	0,85 %	152074,31	0,85 %	-146,914	-0,37 %

Regarding employment effects, the solar PV scenario has a positive net impact on jobs as seen in Table 3, with a percentage increase of around 1% per year. However, it is important to identify where and which jobs will be gained, and which jobs will be lost. Anticipating where jobs will be created and where jobs will be lost will allow for the design of policies and strategies to maximise benefits of job creation and growth of decent jobs and alleviate negative impacts from job losses by identifying opportunities for job transitioning for affected communities. Figure 8 shows relative difference in jobs for the years 2025 (including short-term investment effects), 2030 and 2035 (long-term

structural change effects). There is a relative loss in jobs in the non-renewable electricity sector and in the extractive industries, which can be interpreted as an indirect effect of the reduction in non-renewable energy. These losses are offset by a significant increase in jobs gained in the following sectors: Metallurgy and manufacture of metal products, manufacture of electronic and computer products, manufacture of electrical equipment and materials, financial and insurance activities. These industries are part of the investment value chain required for the installation of solar PV plants, as shown in Table 2.



► Figure 8 – Relative difference in employment to the baseline by industry (excluding solar)



There are additional job gains in the solar sector, as this is a new industry it is not possible to compare its evolution with the baseline scenario. However, in absolute terms, there is a net gain in direct job creation in the solar PV going from around 10 persons in 2025 to 524 persons in 2035. This increase is mainly attributed to male job creation linked with the installation, repair and maintenance, and engineering services required for Solar PV. In aggregate, the solar PV scenario and the transition towards a sustainable electricity system in Ivory Coast would bring positive job gains both from the investments needed to increase the solar PV capacity as the operation of the solar PV industry. To provide a just transition it is necessary that Ivory Coast implements also re-training and relocation options for those workers in sectors that would be affected negatively by the transition.

4.3 Green agriculture scenario: The National Agricultural Investment Programme

Implemented over the period 2010-2015 (extended to 2016), the first-generation National Agricultural Investment Programme (PNIA) enabled the post-crisis recovery of Côte d'Ivoire's agriculture and laid the foundations for a structural transformation of the sector. Côte d'Ivoire's second-generation National Agricultural Investment Program (PNIA 2) is the coherent framework for programming public and private investment in the sector over the next eight years. It covers the sub-sectors of agriculture, livestock, fisheries, aquaculture and environmental management. Its overall aim is to stimulate sectoral growth to halve poverty and achieve "zero hunger" by 2025.

Agriculture is a major driving force behind the Côte d'Ivoire economy, accounting for a significant share of GDP growth because it generates income and added value and generates foreign currency through its exports (40% of national exports in 2013). It plays a central role in eradicating poverty and strengthening the food security of Ivorians.

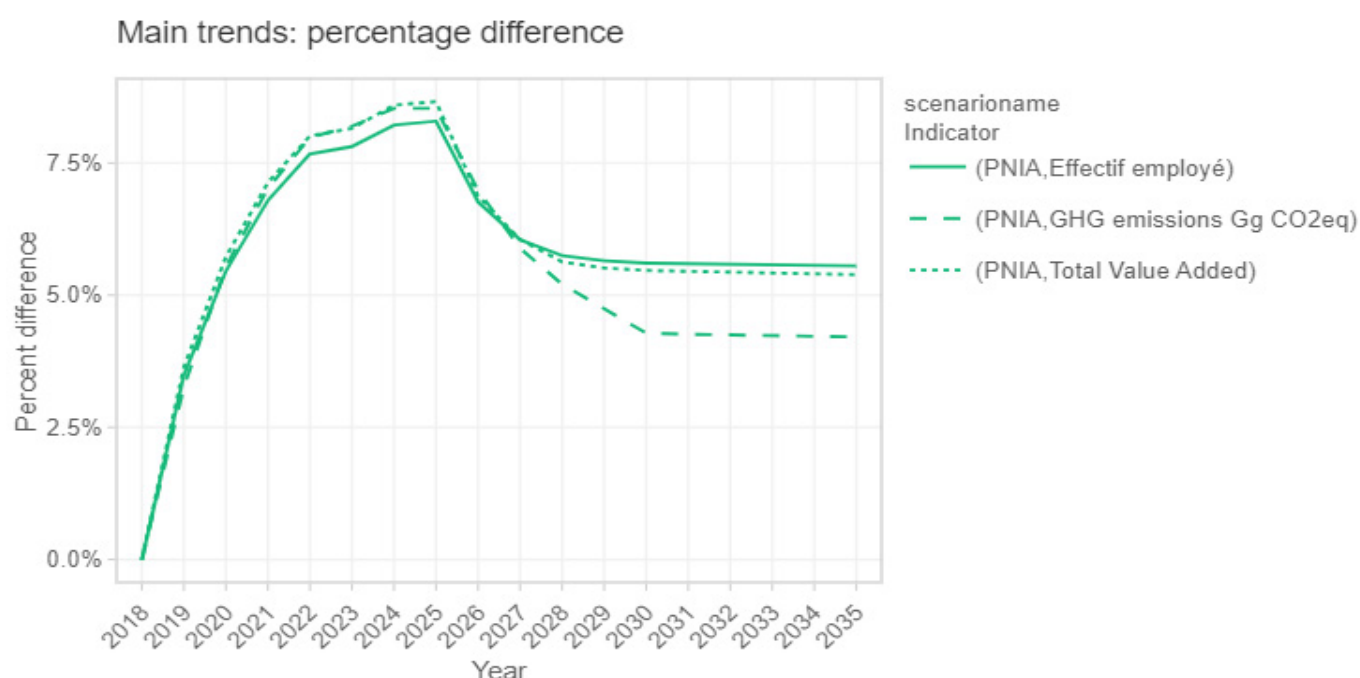
The PNIA 2 proposes a vision of sustainable, competitive agriculture in Côte d'Ivoire, creating wealth that is equitably shared. This vision poses the dual challenge of coordinated development of the agro-sylvo-pastoral and fisheries sectors, and the positive impact of this development on the environment and society. More specifically, PNIA 2 focuses on achieving three strategic objectives:

- The development of agro-sylvo-pastoral and fisheries value-added.
- Strengthening environmentally friendly agro-sylvo-pastoral and fisheries production systems.
- Inclusive growth, guaranteeing rural development and the well-being of populations.

On this scenario, we use the investments required and planned to achieve the PNIA objectives mentioned previously and the renewable energy electricity (Solar PV) investments. The reasoning behind this combination is that in order to achieve a sustainable economy, the push to the economy as a whole due to agricultural investments will require additional energy demand that needs to be renewable to offset the emissions as a result of increasing activities. Both the PNIA activities as described above are modelled together with the Solar PV scenario as described in Section 3.2.

Aggregate results show that main investments for improving the agricultural sector on Ivory Coast imply an increase of more than 5% on employment and value-added when compared to the baseline scenario. Even though there are higher GHG emissions, it is important for the Ivorian economy as these investments will have positive implications on reducing poverty, improving agricultural productivity, and overall putting the whole economy on a higher growth path as it can be seen in Figure 9.

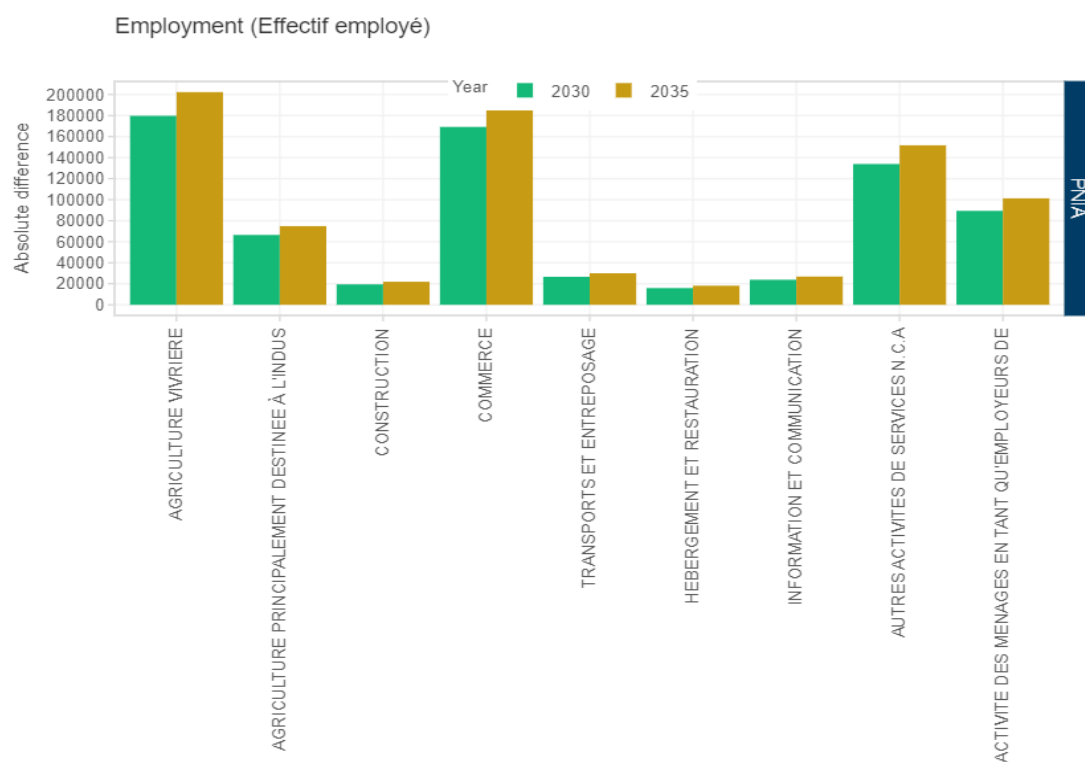
► Figure 9 – Main trends PNIA scenario, percentage difference with respect to baseline



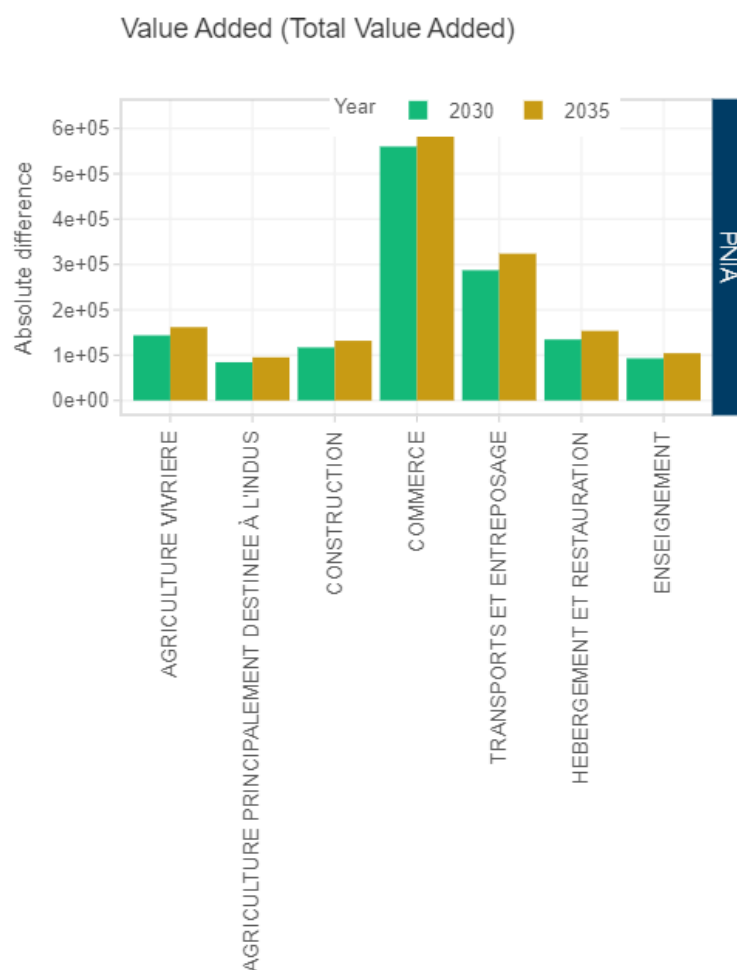
In terms of employment, agricultural investments have positive spillover effects in almost all sectors of the economy. Compared to the baseline scenario, the PNIA scenario leads to a 5% increase in employment in the subsistence agriculture sector and a 2% increase in the industrial agriculture sector. Not only do the investments planned in the scenario directly benefit agriculture-related sectors, but thanks to the higher added value of these sectors and higher house-

hold incomes, there is an increase in employment in trade, transport and storage, as well as in other N.C.A. service activities. Figure 10 shows the main sectors where the PNIA investments have a greater positive impact on employment creation. The same trends are observed on value added, those sectors where demand and employment gains are higher also experience higher value-added production as observed in Figure 11.

► Figure 10 – Absolute increase in employment PNIA scenario 2030 and 2035



► Figure 11 – Changes in Value-added PNIA scenario 2030-2035

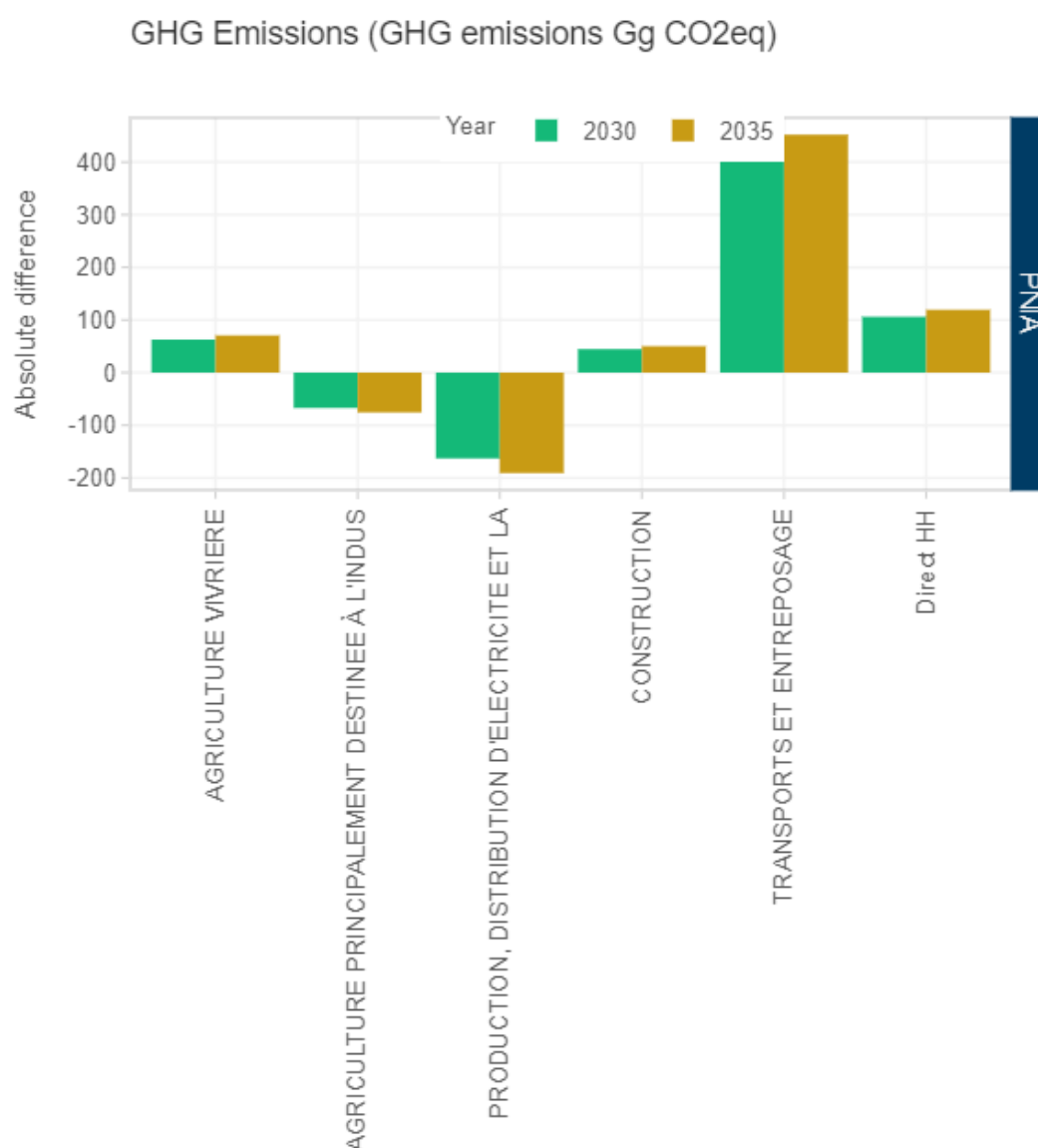


Finally, results for GHG emissions are mixed. In aggregate, emissions are higher than the baseline scenario because of higher economic activity. As shown on Figure 12, the results of this scenario put the Ivorian economy in a path of 5% higher economic growth in the long run when compared to the baseline, something that can be positive for employment creation, income generation and poverty reduction, which aligns with the ambitions of the PNIA. These increases in greenhouse gas emissions are a consequence of higher household incomes. In the context of Ivorian society, higher incomes, particularly in agriculture, translate into poverty reduction and improved well-being for both rural and non-rural households. This, in turn, stimulates increased activity in the commerce and transportation sectors.

However, the PNIA's (National Agricultural Investment Program) plans for sustainable agriculture, along with a renewable energy plan, demonstrate that emissions in the agricultural and energy sectors are lower even with increased production, as illustrated in Figure 12. The implementation of more efficient agricultural practices has led to higher yields with reduced emissions. This aligns with the goal of achieving sustainable industrialization in rural areas, promoting environmental sustainability while boosting economic development. The integration of renewable energy sources further supports this by reducing reliance on fossil fuels, thereby decreasing the carbon footprint of both agricultural and industrial activities.



► Figure 12 – Changes in GHG emissions PNIA scenario 2030 and 2035

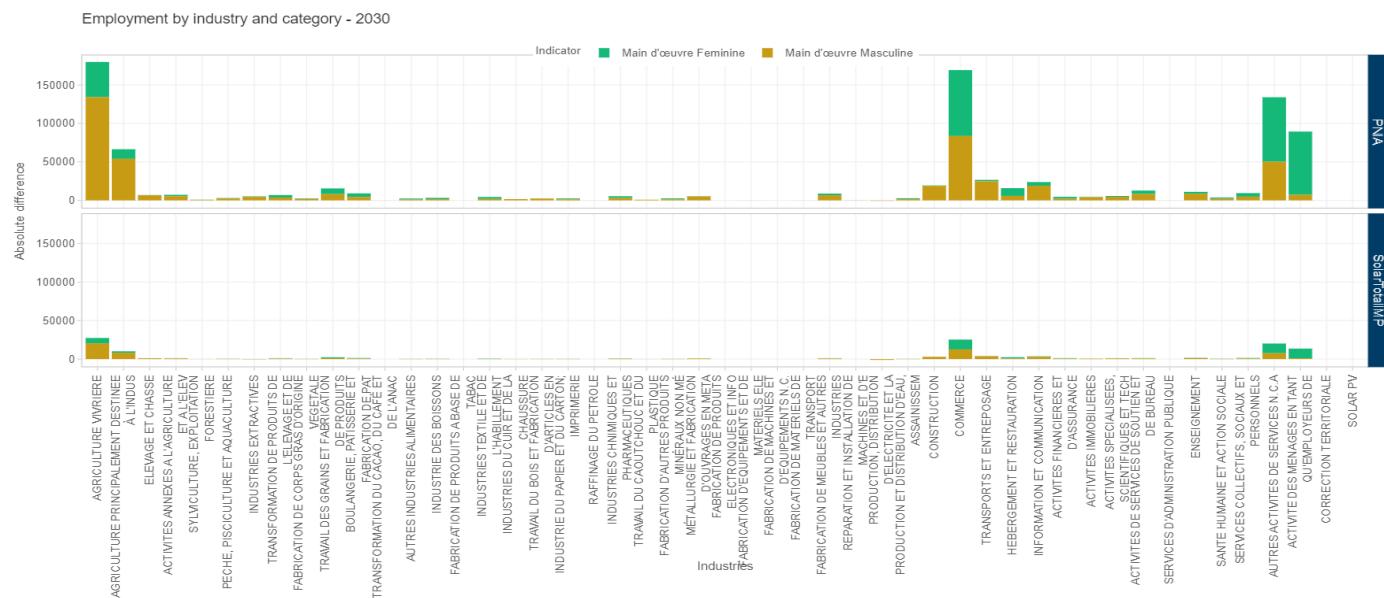


4.4 Comparing green scenarios: effects on employment by gender and skill level

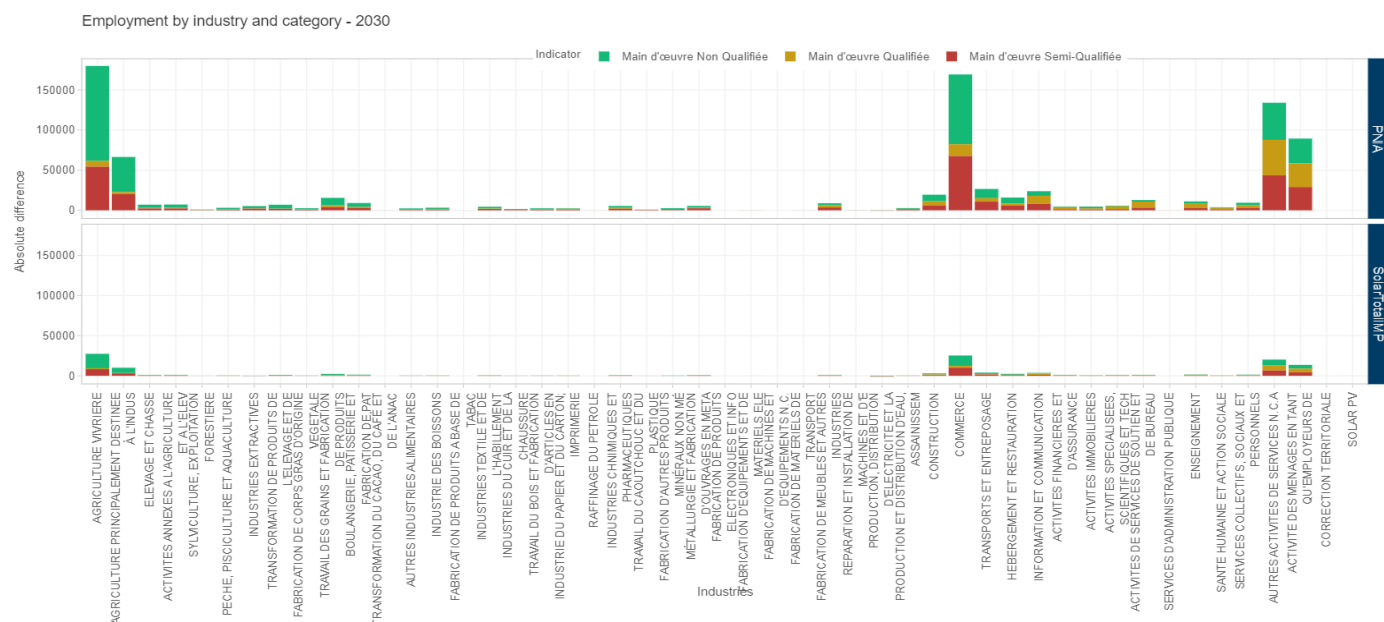
For the two scenarios of energy efficiency and the National Agricultural Investment Programme (PNIA 2), job creation has a positive impact on almost all sectors of the Côte d'Ivoire economy (Figure 13 and 14). The sectors with the biggest increases in employment are: *Agriculture vivrière*, *Agriculture*

principalement destinée à l'industrie, Commerce, Autres activités de services, Activité des ménages en tant qu'employeurs. The PNIA scenario creates more jobs than the Energy Efficiency scenario.

► Figure 13 - Overview of employment effects by gender and industry



► Figure 14 - Overview of employment effects by skill level and industry



A photograph of a woman from behind, wearing a bright blue t-shirt. A baby is strapped to her back, looking over her shoulder. The woman is also wearing a headwrap made of light-colored plastic. The background is bright and slightly out of focus.

**Empowered Women Taking the
Lead in Building Houses with
Low cost Technologies
8th - 30th January, 2010**

► 5. Policy implications and analysis

While it is clear that Côte d'Ivoire's primary goal is economic growth, with less priority given to climate change and environmental protection, the strategic growth sectors promoted by the Government heavily depend on nature and a stable climate. High and long-term growth rates of 7% can thus only be achieved if the basis for economic growth - nature and its assets soils, water, forests, fish and minerals - are managed sustainably.

In addition to Côte d'Ivoire's growth plans, two major policies aim at transforming the economy while also embarking on a sustainable economic growth path. Notably, the National Agriculture Investment Program and the Renewable Energy and Climate Policy. The policies address the current depletion of Côte d'Ivoire's natural assets, such as soil degradation, overfishing, deforestation and unsustainable mining and water use.

Analysing the two policies' impact on employment and economic growth effects, the results indicate that - rather than competing - economic growth go hand in hand with environmental protection: Compared to a business as usual scenario if the Government was to fully achieve the targets set out in the policies - 42 % of renewable energy and increased energy access, a competitive agro-sylvo-pastoral and fisheries sector, improved environmental management, halve poverty and "zero hunger" - aggregate results from this study imply an increase of more than 750,000 new jobs and a 5 percentage point increase of GDP by 2030.

The assessment of the policies' impact clearly show the interlinkages between Côte d'Ivoire's economy and natural capital and climate. Notably, economic and employment gains are up to 5 % higher at the same time as environmental management improves and GHG emissions decline as compared to the business-as-usual development path.

Regarding the policy implications, the results imply that climate change, clean energy and green industry policies are in fact supporting economic and job growth policies.

However, while the economic and jobs creation effect is highly positive in the aggregate, the structural economic and employment change implies shifts between activities with gains and losses occurring between sectors. Job losses are concentrated in fossil fuel and unsustainable economic sectors while gains and opportunities are created in renewable energy and sustainable agriculture-related sectors. In terms of gender, male workers dominate the energy sector, and hence will see the largest gains and losses, while youth tend to gain to find opportunities in emerging new sectors of the economy. Indirect jobs in the supply chain of the energy and agricultural sector also tend to gain, such as retail and commerce where opportunities are created for women and youth.

To enable positive growth effects and a restructuring of the economy towards sustainability the investment into human capital and the skilling, re-skilling and training of workers is central. As there is a relative loss in jobs in the extractive industries those jobs need to be re-skilled and transitioned. Emerging growth sectors with significant demand for new jobs require new curricula, new apprenticeship and initial new skills training in technical and vocational training as well as degrees in renewable energy installation and maintenance, the supplying sectors metallurgy, electronics, informatics, electric machinery, finance and assurance. These industries are part of the investment value chain required for the installation of solar PV plants and hence, in addition to the capital investment, require commensurate investments into human capital. While these jobs tend to be male-dominated, a gender equality policy may be required to increase women's participation, to close the gender pay gaps, to ensure family compatibility and to target training for women and youth. For older workers in unsustainable industries and declining fossil fuel regions, social protection schemes and early retirement policies are required. To enable entire regions which depend on fossil fuels for their income and direct and indirect jobs in restaurants, commerce and retail, Ivory Coast must implement regional structural support programs, including re-training and relocation for communities affected negatively by the transition.

Anticipating where and what type of jobs will be created and where jobs will be lost allows for the design of just transition policies to maximize benefits of job creation and ensure negative impacts from job losses are countered.

In order to finance the investments of physical and human capital, skills and social protection a progressive energy and carbon tax is proposed. It could be channelled through a national Just Transition Fund and trusted to the Central Bank (to ensure earmarked revenue and spending). The rationale of a progressive levy is that the richest 10% of Côte d'Ivoire's population consume some 50% of emissions and energy, while the poorest 50% less than 10%. Exempting and protecting the poorest 50% from energy price increases and subsidy removals and ensuring the well off pay for the negative impact from their pollution would result in an accelerated transition which is just, economically and jobs wise positive, while fiscally neutral.

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► A. Annex: Method and data

A.1 Background and modelling philosophy

The Just Transition Assessment Model developed for Côte d'Ivoire is based on the model suggested in the International Labour Organizations GAIN Training Guidebook (ILO, 2017), adapted to the use of supply-and-use tables. We have further introduced endogeneity of some macro-economic key variables to capture dynamic development paths over time. To this end we follow ideas put forward by INFORUM, the Interindustry Forecasting Project at the University of Maryland (Clopper, 2012). We embed the supply-use model into a set of linear macroeconomic equations. Population and exports are exogenous drivers of the model, while investments (gross capital formation), household demand and GDP (and value added) are endogenous. The model is path-dependent and can be classified as a simple macro-econometric input-output (MEIO) model (Lewney et al., 2018; West, 1995). While similar to computable general equilibrium (CGE) models, the most important differences are that MEIO models are more empirically based (estimation of behavioural parameters), assume myopic foresight of all agents, and have a Leontief production function (Pollitt et al., 2018) in contrast to e.g. a constant elasticity of substitution (CES) production function. Although some price effects are considered in the JTAM model family, these models are to date simpler than other MEIO models, such as E3MG (Mercure et al., 2018) and related models or models from the INFORUM family, such as INFORGE (Maier et al., 2015; Mönnig et al., 2019) for Germany.

The methodology has also been used for the following JTAMs, previously named GJAMs (Green Job Assessment Model): GJAMNigeria (ILO and UNDP, Wiebe, Simas, et al., 2021), GJAMZimbabwe (ILO and UNDP, Wiebe, Andersen, et al., 2021), GJAMTurkey (UNDP and ILO et al., 2022), GJAMBurkinaFaso (ILO, Wiebe, Simas, et al., 2023), and GJAMGhana (ILO, Wiebe, Aponte, et al., 2023).

A.2 Existing economic scenario models in Côte d'Ivoire

Macroeconomic models help calculate the employment effects of specific policies and investments (over predefined scenarios), showing processes of change in the economy as a whole. Literature review on simulation models of the Ivorian economy could be divided into three main types: optimization models, econometric models and system dynamics models.

Computable general equilibrium models (CGMs) are emerging as the most widely used optimization models for policy impact analyzes due to their ability to explore the relationships between sectors, consumers and government and to model the more complex dynamic effects of policies on a variety of macroeconomic parameters, including employment. Classic CGMs are, however, often criticized because

they make the simplistic assumption of a fixed labor supply and a uniform, flexible wage balance between labor supply and demand.

Econometric models use historical data to estimate relationships between key drivers of the economy by simulating changes in exogenous input parameters. However, they cannot be used with confidence to test interventions that have never been implemented. The historical correlation may no longer hold true in the future (Lucas, 1976)⁵.

As for the system dynamics model, it focuses on the identification of causal relationships that influence the creation and evolution of the issues studied. This type of model is most often used as "what if" tools that provide information about what would happen if a certain policy were implemented on a specific date and in a specific context. The pillars of system dynamics are feedback loops, nonlinearity and delays, represented by stocks and flows and identified through the selection and representation of causal relationships existing within the analyzed system (Barlas, 1996). One of the limitations of the model is that it often lacks the level of detail offered by evaluation methods based on input-output (IO) analyzes and the social accounting matrix (SAM).

A.3 Using supply-and-use tables for policy analysis⁶

Policies have effects throughout the economy. A climate or energy policy that affects one industry directly – for example, coal power plants – causes ripple effects throughout the economy. The decrease in the demand of coal will impact the demand for products from the coal mining industry. The decrease in the demand for coal will also affect the demand for machinery and financial services related to coal mining. The reduced demand in machinery will, in turn, affect the demand for metals and components, which will affect the demand for iron ore. The substitution of coal power plants for solar energy for the production of electricity will lead to an increase in the demand for photovoltaic panels and for electric inverters. Those will then increase the demand for electronic components, for products from copper mining and refining, and other industries that provide goods and services for these new products. The direct effects of the policies – decrease of coal electricity, increase of solar electricity – will therefore have indirect economic effects on different industries due to the changes in the demand of goods and services from the industries directly affected, which will also impact their suppliers, and the suppliers of their suppliers, and so on.

The increase or decrease of economic activity will impact jobs. With any policy, there will be industries that will increase their economic output and therefore increase the demand for workers, but there will also be industries that will have a decrease in their economic output, leading to job losses. Assessing the positive and negative impacts of poli-

5. Lucas, R. (1976) "Econometric Policy Evaluation: A critique", Carnegie-Rochester Conference Series on Public Policy, Elsevier, vol. 1(1), pages 19-46, January

6. This section is based on the GJAM report for Turkey (UNDP and ILO et al., 2022)

cies is, therefore, necessary to maximise the potential benefits and minimise potential negative economic, social, and environmental implications.

JTAMs are built to quantify these ripple effects of climate policies and green structural change. JTAMs are macro-economic models based on IOTs or SUTs that integrate economic data with data on jobs and GHG emissions. The starting point are the economic SUTs, compiled by statistical offices. These tables give a picture of the total supply and the total use of goods and services in the economy, quantifying the transactions in products between industries, pur-

chases by final consumers, and to and from international trade. Supply tables describe what industries produce and how much of each product is imported. It also includes the trade and transport margins and taxes less subsidies on products, which represent the difference between the production (basic) prices and the final consumer (purchase) prices. Use tables describe all products used by industries in the country, as well as products purchased by final consumers and exported, and gross value added (VA) generated by industries.

► **Figure 15 – Simplified illustration of a supply table (left) and a use table (right), extended with employment and GHG emissions data per industry.**

Supply table

	Agriculture	Mining	Manufacturing	Services	Imports
Agriculture products					
Mining products					
Manufactured products					
Electricity					
Services					
Total output, industries					

Use table

	Agriculture	Mining	Manufacturing	Services	Final uses	Exports	Total output, products
Agriculture products							
Mining products							
Manufactured products							
Electricity							
Services							
Value added							
Employment							
GHG emissions							

Models based on SUT can simulate the direct and indirect effects of different policies on the economic output of the different industries. Not only that, but supply-and-use and input-output tables can be linked with social and environmental indicators (called extensions) that describe direct impacts of each industry on workers and on the environment. A simplified supply-and-use table is illustrated in Figure 14.

Note that we do not model inflation. The only price changes that can be modelled are those due to changing technology of production in the scenarios, which are reported in constant prices.

The model iterates in every year until the change in final household demand from one iteration to the next is below a given threshold. The next year is then initialised with endogenous variables being set to the current year solution and exogenous variables as well as scenario inputs taking the next year's value.

For the scenarios it is possible to model

- additional investment by product
- changes in the structure of household and government demand
- changes in the use coefficient matrix, i.e. the technology with which an industry produces
- changes in the market share matrix, i.e. which industries produce which share of a product
- changes in the import shares by products
- changes in emission intensities of industries

Production and value added are always endogenous. From this we can estimate changes in employment by using a constant labour intensity (that is, a fixed number of workers by skill and gender per unit of value added by industry) multiplied with the new value added by industry.

► General limitations and strengths of the modelling approach

Excerpt from general documentation of the software for the economic core model (SUT_core)

SUT based macro-econ(etr)ic IO models / GAIN type Just Transition Assessment Models are not economic forecasting models. Rather, these models are a tool to inform about possible effects of “what-if” scenarios on emissions and labour demand by industries, given that the remaining structure of the economy remains as is.

The results should be assessed relative to the reference scenario. They indicate the direction and possible size of the effects but should be taken as indicative estimates.

The results show how changes in individual economic activities influence the economic structure. Direct, indirect, and induced effects of technological change and changes in household, government and investment structure are reflected.

A(n imperfect) list of limitations to the modelling approach

- The model is based on historic relation between economic activity, income and consumption and the production structure of the base year, which in turn might be estimated based on older supply-and-use tables. For some countries, the most recent available SUT might be from 2010 or 2012, while other countries might have tables as recent as 2019. Extrapolating data over the next decade based on such data will not necessarily give a complete picture, but it constitutes a valuable starting point for assessing effects of climate change mitigation and adaptation and other sustainability policies through “what-if” analyses.

While the option for price changes is given, there is no adjustment of production structure or investments based on price changes. Household demand for different product groups, however, is modelled using own- and cross-price elasticities.

- Investments grow with the previous year’s growth rate, and the structure of the investment remains the same, with one exception: the exogenously given investment for individual scenarios, which comes in addition to the general investments. This entails that the additional investments in the scenarios are not crowding out other investments but come as an additional economic stimulus.
- The results show which industries are likely to have an increased demand for labour, and which industries might contract. The actual labour market outcomes also depend on other factors as well as dynamic labour market adjustments such as wage adjustments, labour availability, labour productivity changes etc, that are not considered here.
- The current modelling of international trade is very simplified. Import shares by product are based on the supply table from the base year. Exports grow with global GDP projections from the IMF or OECD.

Once these limitations are well understood, they contribute to the **main strength of the model: simplicity and transparency**. These are reinforced by the other strengths:

The model depends on very few types of data, which can be combined into one consistent framework with few equations.

- The model is data-driven and reflects country-specific characteristics very well.
- Scenarios are implemented using one Excel sheet and the model runs in only a few seconds, which allows to calculate a large number of scenarios and thereby assessing the validity of different scenario assumptions.
- For every single result, we can find an explanation that is in the data or one of the very few assumptions underlying the model.

A.4 Data for the Just Transition Assessment Model

A.4.1 Overview over data sources for the Just Transition Assessment Model

This section describes the data sources needed to develop the JTAM.

Supply-and-use table for the most recent year available

In this report, we used the **SUT of the year 2018**, as provided by the researchers of the University of Nangui Abrogoua which describes the economy in 2018 for 47 products and industries, (see Table A1 and Table A2 in appendix for a detailed industry and product detail). The base year for the analysis in this report is hence 2018, and all economic growth is estimated based on 2018 constant prices.

Macro-economic time series

The model considers the past and current state of the economy as described by data from the System of National Accounts (UNSD, n.d.), that is the macro-economic values for final household and government consumption expenditure, gross fixed capital formation, imports, and exports, as well as value added with as much industry and component (e.g. net taxes on production, compensation of employees, net operating surplus) as possible. The SUT should adhere to these macro-economic key indicator values.

For the econometric estimations, we use a historical time series of data from 1970 to 2018/the UN System of National Accounts. Please see Section A.1 for a detailed description of the econometric model. The estimated parameters together with exogenous information on the development of exports, global economic and population (UN, 2019) growth, are the main parameters defining the baseline scenario pathway.

Labour data

The **labour data** used comes from the researchers of Nangui Abrogoua University and it is based on the total employments by sector as registered in the TRE 2018 adapted with microdata from a 2015 household survey (Institut National de la Statistique, n.d.) which allows to get employment indicators per gender, skill-level, and geographical composition (urban, rural). The total employment indicators available in the JTAM Côte d'Ivoire model is available in Table A3.1 in the appendix.

Greenhouse gas emissions

The **GHG emissions data** used comes from the Emissions Database for Global Atmospheric Research (EDGAR). The EDGAR database is an international database for air emissions, including the GHG emissions carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), which are used in the JTAM. The emissions in the EDGAR database are reported in kilotons of each gas per activity, following the 2006 IPCC guidelines for reporting GHG inventories, and for every year between 1970 and 2021.

The available GHG emission indicators and their distribution in total emissions in 2018 is available in Table A3.2 in the appendix. Most of the emissions from the EDGAR database have a direct correspondence: 76.6% of CO₂ emissions, 99.95% of CH₄ emissions, and 93% of N₂O emissions, which

totalise 86% of total GHG emissions, can be allocated to one specific industry in the SUT, and no assumptions were used. For emissions from fossil fuel combustion, when allocation was necessary between one inventory activity (e.g. 1.A.2 Emissions from fuel combustion in manufacturing industries and construction) and two or more industries in the SUT, emissions were allocated based on the share of fossil energy products use by industry from the use table. The available GHG emission indicators and the correspondence between original activity in the GHG inventory and allocation to the 47 SUT industries and to households is available in Table A3.3 in the appendix.

Data for splitting electricity industry

Modelling the effect of the growth of solar PV requires the **split of the original electricity generation industry** into solar PV electricity and the remaining electricity generation technologies. Given that solar production in the country was negligible in 2018 (our base year), solar PV has been included as a new industry in the supply table; data on the use of inputs to produce electricity (Castillo Ramírez et al., 2017; Committee on Climate Change, 2011; Invest for Jobs et al., 2021; MacDonald, 2011) (i.e. the operation of the power plants, not counting construction and investments) from solar is used to estimate the industry structure of the green electricity in the use table. Table 4 presents the input distribution of solar PV after adapting the data of xx to the SUT of Côte d'Ivoire.

► Table 4 – Input distribution Solar PV

Products	Solar PV
Electronic and IT Products	0
Electrical Equipment and Materials	0,157
Repair and Installation of Machinery and Equipment	0
Electricity Production and Distribution	0,199
Water Production and Distribution, Sanitation	0
Construction work	0,0182
Financial and Insurance Services	0,165
Real estate services	0
Specialised, Scientific and Technical Activities	0,055
Value-added	0,4036
Total Production	100%

A.4.2 The Côte d'Ivoire supply and use table

The SUT for Côte d'Ivoire shows the flows of goods and services between industries and final consumers, in CFA, for 2018. It describes the entire production economy in 47 products and industries (Table 5 and Table 6) and final users of goods and services (Table 7), besides the volume and distribution of value added in each industry (Table 8). The supply table describes the total supply of the 47 products in the economy and how those products are distributed by the 47 supplying industries and imports.

► **Table 5 – List of SUT 47 products**

Products SUT 2018 Côte d'Ivoire
Food crops
Agricultural products mainly intended for
Livestock and hunting products
Support services for agriculture and livestock farming
Forestry and logging products
Fishing, fish farming and aquaculture products
Mining and quarrying products
Meat, meat products and animal fats
Fats and oils
Grain products and starch products
Bread, pastries and pasta
Cocoa, coffee and tea products
Other food products
Beverages
Cigarettes and other tobacco products
Textile and clothing industries
Leather goods; travel goods; footwear
Wood, wood products and basketry
Paper and cardboard products
Refined products
Chemicals and pharmaceuticals
Rubber and plastic products
Non-metallic mineral products
Metallurgical products; metal products
Electronic and computer products
Electrical equipment and materials
Machinery and equipment n.e.c.
Transport equipment
Furniture, miscellaneous products
Repair and installation of machinery and equipment
Electricity production and distribution
Water production and distribution, sanitation
Construction work
Trade
Transport and storage services
Accommodation and catering services
Information and communication services
Financial and insurance services
Real estate services
Specialised, scientific and technical activities
Support and office services
Public administration services
Education
Human health and social work services
Community, social and personal services
Other service activities n.e.c.
Activities of households as employers

► **Table 6 – List of SUT 47 industries**

Industries SUT 2018 Côte d'Ivoire
Food crops
Agricultural products mainly intended for
Livestock and hunting products
Support services for agriculture and livestock farming
Forestry and logging products
Fishing, fish farming and aquaculture products
Mining and quarrying products
Meat, meat products and animal fats
Fats and oils
Grain products and starch products
Bread, pastries and pasta
Cocoa, coffee and tea products
Other food products
Beverages
Cigarettes and other tobacco products
Textile and clothing industries
Leather goods; travel goods; footwear
Wood, wood products and basketry
Paper and cardboard products
Refined products
Chemicals and pharmaceuticals
Rubber and plastic products
Non-metallic mineral products
Metallurgical products; metal products
Electronic and computer products
Electrical equipment and materials
Machinery and equipment n.e.c.
Transport equipment
Furniture, miscellaneous products
Repair and installation of machinery and equipment
Electricity production and distribution
Water production and distribution, sanitation
Construction work
Trade
Transport and storage services
Accommodation and catering services
Information and communication services
Financial and insurance services
Real estate services
Specialised, scientific and technical activities
Support and office services
Public administration services
Education
Human health and social work services
Community, social and personal services
Other service activities n.e.c.
Activities of households as employers

► **Table 7 – List of final demand**

Final demand categories
Household consumption expenditure
Government consumption expenditure
Non-profit organizations serving households (NPISH)
Gross fixed capital formation
Changes in inventories
Exports

► **Table 8 – Value added categories**

Value Added categories
Gross wages
Actual social security contributions
Imputed social security contributions
Production taxes
Production subsidies
Gross operating surplus / mixed income

A.4.3 Measuring impacts: Labour extensions

Labour extensions refer to the employment statistics from the annual household survey and the bureau of statistics, allocated to each industry in the SUT. For each industry, we have the amount of people employed per gender, skill level, and geography. The labour extensions in JTAMCôte d'Ivoire are made of 12 indicators as detailed in Table 9.

► **Table 9 – All indicators available in labour extensions, and the distribution of employment in 2018**

Gender	Geography	Skill level	Share
Male	Rural	Non-qualified	25,247 %
Male	Rural	Semi-qualified	14,480 %
Male	Rural	Qualified	2,672 %
Male	Urban	Non-qualified	7,332 %
Male	Urban	Semi-qualified	9,302 %
Male	Urban	Qualified	6,965 %
Female	Rural	Non-qualified	12,199 %
Female	Rural	Semi-qualified	2,947 %
Female	Rural	Qualified	0,321 %
Female	Urban	Non-qualified	7,477 %
Female	Urban	Semi-qualified	6,022 %
Female	Urban	Qualified	5,037 %

A.4.4 Measuring impacts: GHG emission extensions

GHG emissions extensions refer to the GHG emissions statistics from the EDGAR database, allocated to each industry in the SUT. For each industry, we have the emissions per gas and main activity (energy use, industrial production, agriculture, and waste management). The GHG emissions extensions in JTAM Côte d'Ivoire are made of 12 indicators as detailed in Table 10.

► **Table 10 – All indicators available in GHG emissions extensions, and the distribution of emissions in 2018 by activity and by gas**

Gas	Activity	Emissions in 2018 (kt)	Share in total emissions	Share per gas
CO ₂	Energy emissions	10208	47%	58%
	Industrial emissions	2002	9%	
	Agriculture	379	2%	
	Waste management	0	0%	
CH ₄	Energy emissions	1486	7%	40%
	Industrial emissions	0	0%	
	Agriculture	3013	14%	
	Waste management	4280	20%	
N ₂ O	Energy emissions	76	0%	2%
	Industrial emissions	0	0%	
	Agriculture	53	0%	
	Waste management	245	1%	

Table 11 shows the distribution of emissions from activity in the original data to the SUT industries. This distribution was done, mostly, by a direct correspondence between activity and industry: 76.6% of CO₂ emissions, 99.95% of CH₄ emissions, and 93.3% of N₂O emissions were allocated from the original activity to a single industry. For the remaining, emissions were distributed according to the use of reference products by each of the corresponding SUT industries. For energy emissions that span over multiple industries (categories 1.A.2 – Manufacturing industries and construction and 1.A.4 – Residential and other sectors), the reference was the use of fuel products (Produits du raffinage / Products from petroleum refineries) as these categories refer to the emissions from the combustion of fossil fuels by industry, services and households. For non-energy emissions, the only activities that needed the distribution between multiple industries were agricultural CO₂ emissions from liming and from urea application (fertilizer), distributed between *Agriculture vivrière* and *Agriculture principalement destinée à l'industrie*. Liming is performed by applying calcium- and magnesium-rich materials on the soil. For the distribution of emissions from liming, the reference was the use of non-metallic mineral products (Produits minéraux non métalliques) by the two agricultural industries. For the urea application, the reference was the use of chemical products (Produits chimiques et pharmaceutiques).

► **Table 11 – Correspondence between emissions from the original activities in the EDGAR database and the SUT industries**

EDGAR Activities CO ₂		Share in total emissions, per gas			Correspondence to SUT industries
		CH ₄	N ₂ O		
1.A.1.a	Main Activity Electricity and Heat Production	26.1%	0.07%	0.4%	Electricity production and distribution
1.A.1.bc	Petroleum Refining - Manufacture of Solid Fuels and Other Energy Industries	2.3%	0.00%	0.1%	Oil refining
1.A.2	Manufacturing Industries and Construction	10.0%	0.01%	0.5%	All manufacturing industries except petroleum refinery (22 industries) plus Construction (1)
1.A.3.a	Civil Aviation	0.2%	0.00%	0.1%	Transport and storage
1.A.3.b	Road Transportation no resuspension	28.3%	0.3%	11.2%	
1.A.3.c	Railways	0.3%	0.00%	1.2%	
1.A.3.d	Water-borne Navigation	2.7%	0.01%	0.7%	
1.A.4	Residential and other sectors	10.4%	0.03%	6.2%	Households, agriculture industries and other extractive industries, and all services except for transport, construction and utilities (1)
1.B.2	Oil and Natural Gas	0.8%	16.5%	0.1%	Extractive industries
2.A.1	Cement production	12.6%			Manufacture of other non-metallic mineral products
2.A.3	Glass Production	0.01%			
2.A.4	Other Process Uses of Carbonates	0.02%			
2.D	Non-Energy Products from Fuels and Solvent Use	3.2%			Chemical and pharmaceutical industries
2.G	Other Product Manufacture and Use			0.02%	Manufacture of electronic and information products
3.A.1	Enteric Fermentation		25.4%		Livestock farming and hunting
3.A.2	Manure Management		1.3%	12.5%	
3.C.2	Liming	2.8%			Food production, agriculture mainly for industry (2)
3.C.3	Urea application	0.2%			Food production, agriculture mainly for industry (3)
3.C.6	Indirect N ₂ O Emissions from manure management			1.7%	Livestock farming and hunting
3.C.7	Rice cultivations		7.6%		Food production
4.A	Solid Waste Disposal		10.4%		Water production and distribution, sanitation
4.C	Incineration and Open Burning of Waste		0.36%		
4.D	Wastewater Treatment and Discharge		38.0%	65.4%	

Notes: Distribution from original activity to multiple SUT industries followed the use of the following products by the SUT industries in the same activity: (1) Produits du raffinage; (2) Produits minéraux non métalliques; and (3) Produits chimiques et pharmaceutiques.

LULUCF emissions

While agricultural emissions can be easily related to economic activity, emissions from Land Use, Land-Use Change and Forestry (LULUCF) cannot be allocated to the JTAM. This emissions category describes carbon emissions and sinks per land type and per change of use in land type between years. These include, for example, changes in forest and other woody biomass stocks; forest and grasslands conversions: abandonment of croplands, pastures, or other managed lands; changes in carbon content of soils; or natural disturbances such as forest fires in managed lands or in unmanaged lands when those disturbances are followed by land-use changes.

The emissions and sinks associated to land use and land-use change do not depend directly on economic activity, but on many different factors. The JTAM assumes direct relationship between economic output and emissions. While this relationship can be assumed for the emission categories accounted in the model (for example, higher output from animal husbandry would lead to higher emissions from manure management and from enteric fermentation), the relationship between economic output and land-use change is not direct. Increased agricultural output comes, often, from increased productivity, and not necessarily from increased land use. For this reason, it cannot be established a direct correlation between increased economic activity of different industries to changes in carbon emissions or sinks in the LULUCF accounts.

An approximation for reflecting emissions from land degradation and/or deforestation is by accounting for emissions from the burning of firewood and charcoal for cooking and heating. In countries with a large consumption of traditional biomass by households and in economic activities, and where there are established links between collection of fuel wood and deforestation or land degradation, these emissions can be used as a proxy for covering parts of LULUCF emissions. The main assumption, in this case, is that the fuel wood comes from unmanaged lands and contributed to reduced carbon stock in forests, since managed forestry is not considered to represent net emissions.

Following the same reasoning, nitrogen emissions from managed soils cannot be allocated to economic activities, as there is not a linear relationship between agricultural output and growth of land use, or of activities that can influence the nitrogen release from managed soils.

A.5 Baseline development⁷

The purpose of having this reference scenario is to have an economic development which can serve as a baseline to which the development in the green scenario can be compared. Here, we assume that the economy grows (as specified in the following paragraphs), but the structure of the economy does not change. That is, industries continue to produce using the same production technology and the import shares of products remains stable. The model drives growth as follows:

- Government consumption grows (exogenous to the model) with the average growth rate of government expenditures for the years 2010-2018.
- Gross fixed capital formation (exogenous to the model for the current year) grows with the previous year's GDP growth rate.
- Exports (exogenous to the model) grow with the global GDP growth rate.
- Changes in inventories (exogenous to the model) decrease by 1% annually.

Household consumption is endogenous to the model, as is GDP (the sum over all industries' value added). The household consumption model utilises income elasticities from USDA international food comparison programme (Meade et al., 2014; Muhammad et al., 2015) for nine consumption categories, see Table 12. The change in household income for the consumption model is approximated by the change in GDP.

7. Based on the description of the baseline scenario used for GJAM Turkey, but adapted to the model for Côte d'Ivoire.

► **Table 12 – Income elasticities for broad consumption categories for Côte d'Ivoire from the USDA international food comparison programme (Meade et al., 2014; Muhammad et al., 2015)**

Food, beverages & tobacco	Clothing & footwear	Housing	House furnishing	Medical & health	Transport & communication	Recreation	Education	Other
0,795	0,968	1,075	1,055	1,735	1,216	2,372	0,931	1,753

The economic structure (described by the market share matrix D , calculated from the 2108 supply table) and the technology coefficient matrix B (calculated from the 2018 use table) are kept constant for the years 2020-2035. This entails that the economy is assumed to have a static Leontief production function without technological change or any economies of scale or price effects. Import shares per product are constant. As there is no technological change or changes in the structure of primary inputs (value-added components), prices are constant.

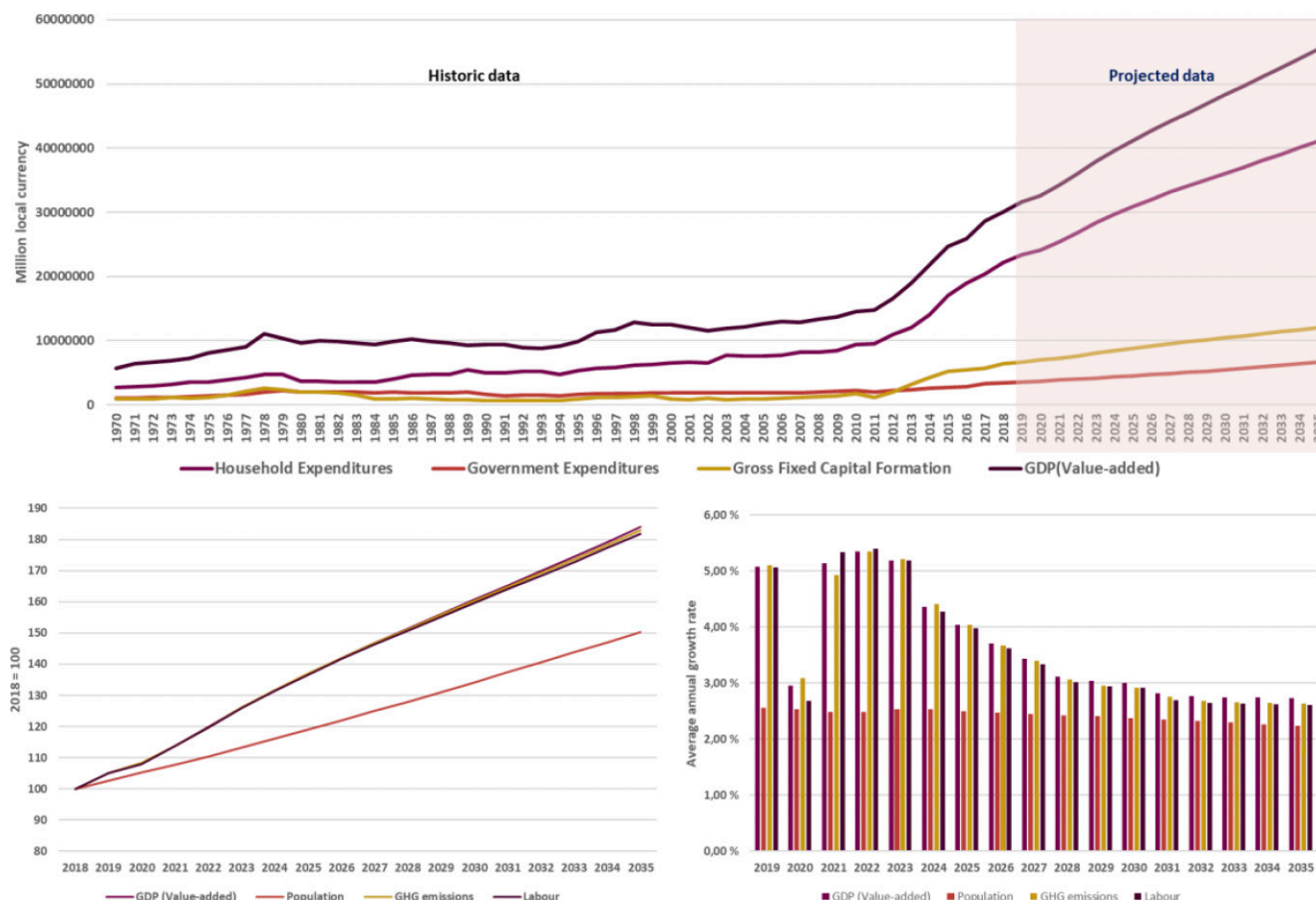
Production by industry g is calculated using the industry-by-commodity commodity-demand-driven SUT model (Miller & Blair, 2009) $g = D(I - BD)^{-1}y$. In this demand-driven model, this results in for example electricity production growing with electricity demand in monetary terms.

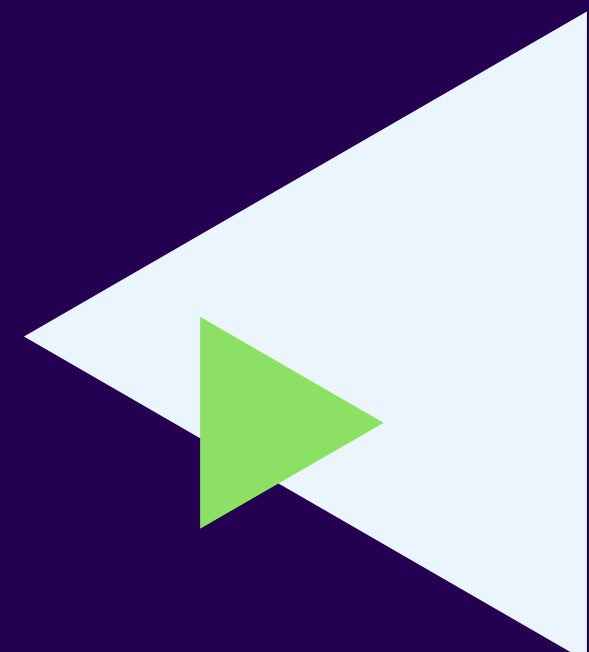
Since the technology coefficient matrix B is constant, the share of value added in total industry output is also constant. Value added per industry is then determined endogenously by multiplying the value added in output shares with output per industry. Total GDP equals the sum over all industries' value added and is then used to determine the development of household consumption expenditures.

In this reference scenario we assume constant labour productivity (persons employed per unit industry output). To estimate the employment requirements, we thus multiply the (constant) number of per unit of industry output with the projected output by industry in monetary terms. The same procedure is used for GHG emissions. Note that the model (akin to other macro-economic models (Rosendahl et al., 2021)) does not include land use, land use change and forestry (LULUCF) emissions.

Figure 15 displays key macroeconomic indicators for the baseline scenario. The top panel of the figure shows both historic and modelled baseline macroeconomic variables: GDP, household consumption expenditures, government expenditures and gross fixed capital formation. The lower left panel shows the relative development of population, GDP from the production side (= value added), GHG emissions and number of workers (employment). The lower right panel shows respective annual growth rates. In the baseline scenario, the economy of Côte d'Ivoire is projected to have high growth rates for the 2020's and then it converges to the world growth rate in the 2030's.

► **Figure 16 – Baseline scenario: Macroeconomic trends**





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