INSTITUTE FOR SUSTAINABLE RESOURCES

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Greening the Recovery in Ghana

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Executive summary

The Covid-19 pandemic has had widespread impacts around the world. These impacts have been severe for the health of populations and economies, and have prompted calls to re-think the direction of economic and social development. Arguments for a more sustainable, green model of development have been strengthened by the increasing impacts of climate change and the global energy crisis.

This report sets out some results and recommendations from a two-year research project on Greening the Economic and Social Recovery in Ghana and Zambia. The project was carried out by research teams at UCL in the UK, the University of Ghana, Ghana and the Zambia Institute for Policy Analysis and Research.

The teams analysed stakeholder views on what a green recovery from Covid-19 could look like, co-developed future economy-wide scenarios with these stakeholders, analysed the energy system implications using quantitative models, and developed recommendations for policy makers.

This report focuses on results and recommendations for Ghana. The project team co-developed two potential pathways for greening the recovery in Ghana based on the inputs of stakeholders. The Leapfrog scenario, includes decisive action to move away from fossil fuels and decarbonise the economy, aided by international climate finance and a focus on developing national capabilities and jobs. The Blended scenario takes a more incremental approach, with continued investment in fossil fuels alongside cleaner technologies – and a gradual phase down of these fuels in the longer-term.

We conclude that a development pathway that is similar to the Blended scenario should be the focus for the remainder of this decade due to the unhealthy state of the present economy. However, there is also an opportunity to use the next few years to lay the required foundations for a more decisive shift to a sustainable development pathway. If these foundations are put in place, Ghana could implement more ambitious strategies that are consistent with the Leapfrog scenario from the early 2030s.

To support a green recovery, the report makes seven recommendations to policy makers in Ghana:

- **Align Ghana's major development frameworks so they support a shift towards a green economy.** This would require sustainability to be 'mainstreamed' in the Medium-Term National Development Policy Framework (MTNDPF), the Coordinated Programme for Economic and Social Development Policies and other long-term plans and policies.
- **Restructure Covid-19 recovery policies and programmes so that they have a greater focus on green transformation.** For example, the landmark Covid-19 Alleviation and Revitalization of Enterprises Support programme for the country needs reorientation to encompass a more specific focus on environmentally sustainable businesses and products.
- **Update the scope and orientation of policies for decarbonisation and sustainability.** In particular, the Environmental and Sanitation policy, the Ghana National Transport policy, and the National Water policies should be reviewed and updated as a matter of urgency since they do not fully integrate sustainability goals.
- **Revamp and sustain existing green transport initiatives in Ghana.** These include the Bus Rapid Transport (BRT) initiative, which still requires dedicated bus lanes, and investment to enable the electrification of rail and road transport.
- **Ensure that policies for individual sectors are compatible with green economic development.** For example, policies to promote electric cooking and mass transport need to take into account the electricity needs of industry, and that there is enough investment in low-carbon electricity.
- **Development of innovative financing and incentives for green initiatives.** The importance of funding to shore up a green recovery in Ghana cannot be overemphasized. Given the dire financial state of Ghana, innovative ways to attract private sector investment will be required.
- **Strengthen administrative and fiscal decentralisation to Metropolitan, Municipal and District Assemblies.** These Assemblies have a key role to play in the shift to a greener economy, but will require sufficient resources to play this role.

1. Introduction

The impact of the COVID 19 Pandemic is global in scale. Alongside the high mortality rate is the near collapse of economies with dire consequences on livelihoods due to lockdowns and curtailment of movements of goods, services, and people. Although the effects have been felt by everyone, the poor and vulnerable in society have borne the greatest effects. These effects only added to existing global challenges. Changes in climatic conditions and their associated impacts continue to be felt globally. The stresses and impacts of climate change are estimated to have greater consequences for sub-Saharan Africa where the combination of limited technological, poor infrastructural and low adaptive capacities make the sub-continent more susceptible to extreme climate events.

Recovery from the pandemic, therefore, must include enhancing sustainability and resilience. One of the key arguments to reinforce sustainability is the need to take advantage of the economic restructuring necessary to recover from the economic impact of the pandemic to transition towards greater investments in green energy (through de-carbonisation). Green approaches are considered to be critical pathways to reducing carbon emissions in the pursuit of sustainability.

Since the signing of the Paris Agreement in 2015, Ghana has established its firm commitment to contribute to reducing greenhouse gas emissions (GHGs). The Ghana Nationally Determined Contribution (which will be called GH-NDCs throughout this report) serves as the blueprint for action and accountability (GoG, 2015). The first GH-NDCs contained 31 specific programmes targeting seven key priority areas. Through defined policies, specific sectors are mandated to work on these priority areas in addition to the responsibilities for the implementation, management, and regulation to ensure compliance. Though the GH-NDCs have been updated to reflect changes in priorities, the commitment to reduce carbon emissions through enhanced social and economic capacities is strongly maintained.

The updated GH-NDCs (MESTI, 2021) which was unveiled at the Conference of Parties (COP26) meeting in Glasgow in 2021 has a total of 19 policy actions in 10 priority areas to achieve the enshrined goals in the next decade. The 19 policy actions translate into 13 adaptation and 34 mitigation programmes of action. Ghana aims to implement 9 unconditional programmes of action that would result in 8.5 MtCO2e GHG reductions by 2025 and 24.6 MtCO2e by 2030 compared to emissions in a baseline scenario. Additionally, 25 conditional programmes of action are earmarked to potentially achieve an additional 16.7 MtCO2e reduction of GHG by 2025 and 39.4 MtCO2e reduction of GHG by 2030. These additional reductions require financial support from the international community and private sector to cover the full cost of implementation.

In addressing the shortcomings of the previous GH-NDCs, the updated GH-NDCs document drives home the need to remove the systemic institutional, policy, and financial barriers in order to realise its goals for the benefit of society, especially the lives of the vulnerable. Against this backdrop, three institutions and their allied agencies have been assigned specific tasks to facilitate the GH-NDCs coordination and collaboration: the Ministry of Environment, Science,

One of the key arguments to reinforce sustainability is the need to take advantage of the economic restructuring necessary to recover from the economic impact of the pandemic to transition towards greater investments in green energy

Technology, and Innovation (MESTI) and the Environmental Protection Agency (EPA); Ministry of Finance (MOF); and the National Development Planning Commission (NDPC).

The volatile global energy landscape presents enormous threats and opportunities. The increase in global oil and gas prices in the wake of Russia's invasion of Ukraine alongside rising inflation and cost of living across the globe have the potential to erode significant gains made in the sustainability agenda. These challenges, however, highlight the urgent need to reduce fossil fuel dependence and step-up green energy actions - despite the short-term costs. A sudden or gradual transition to greener energy sources may be pursued. It is, however, not in doubt that a green agenda is essential.

The Greening Recovery in Ghana and Zambia project, which views climate change as one of the most pressing global challenges alongside the COVID-19 pandemic, seeks to assess and examine opportunities for integrating economic recovery and climate change policies in Ghana and Zambia. Specifically, the project sets out to achieve four key objectives. First, to understand the drivers, challenges and opportunities for integrating green approaches in the recovery process. Second, to investigate options for change. Third, to support the development and implementation of policies aimed at deepening the integration of green approaches into the recovery process. Fourth, to build capacity through training programmes.

The following sections of this report discuss the results of the project. Section 2 explores the impacts of Covid-19 in Ghana and potential responses. It draws on a review of policies and documents related to the GH-NDCs and COVID-19 recovery in Ghana, and a series of stakeholder interviews. Section 3 sets out two scenarios for a green recovery in Ghana, based on the stakeholder interviews and workshops on relevant issues for national development. The workshops were designed to encourage consensus building in order to make the outputs relevant, applicable, and engender support from all sectors. Section 4 reports key results from quantitative modelling of the green recovery pathways, with a focus on the energy sector. Finally, section 5 sets out some key policy recommendations based on our analysis. These recommendations were discussed with the project advisory group members, drawn from HATOF Foundation, Ghana; Forestry Commission, Ghana; Ministry of Food and Agriculture, Directorate of Crop Services; Ministry of Finance; and United Nations Development Programme.

The project team would like to thank all those who contributed to the project's research, including those who agreed to be interviewed, participants in stakeholder workshops and members of the project advisory group. The research was funded by UK Research and Innovation through the Global Challenges Research Fund.

2. Impacts and responses to Covid-19 in Ghana

The Covid-19 pandemic had, and continues to have, severe impacts on every facet of people's lives in Ghana. Aduhene and Osei-Assibey (2021) explored the impact of the Covid-19 pandemic on the Ghanaian economy. They highlighted the deepening of individual and collective vulnerabilities and the weakening state of the health systems of the country. They stressed the need for the country to take full advantage of the situation to address systemic challenges in the health sector. During interviews, many of the experts noted that a far-reaching implication of the Covid-19 pandemic was the inability of the government to pursue planned social and economic programmes due to unplanned spending and the knock-on impacts on debt. A heavy burden had been placed on the financing capacity of the country through government intervention during the Covid-19 induced lockdowns in the early part of 2020. Emergency response plans, which included free electricity and water, resulted in the reallocation of resources originally intended for other uses.

The lack of capacity and resourcing was revealed at the peak of the Covid-19 in April 2020. As highlighted by some of the experts interviewed, the challenges with institutional capacity coupled with the collapse of traditional support systems and the lack or non-existence of institutionalised social security for people in the informal sector, heightened sensitivity to social, economic and global shocks such as Covid-19. The extreme deprivation experienced by a large proportion of people, most of whom were in the informal sector, within the three-week lockdown, was a clear indication of systemic failures and the need to take decisive action to forestall future crises.

Some interviewees argued that Covid-19 had created opportunities to think about and look at things differently. Indeed, pursuing a pathway that would enhance adaptation and resilience to future emergencies was stressed by many stakeholders. Most of the specific suggestions and recommendations focused on governance and related to: responsiveness and a greater sense of responsibility by the political leadership and public officials; institutional strengthening and capacity building; improving social protection and care for the underprivileged and vulnerable in society. Another specific opportunity mentioned is related to the enhanced appreciation for and use of locally produced goods, including agricultural produce.

However, despite optimism that the pandemic could lead to a focus on green solutions, the Ghanaian government's response to the pandemic – the Ghana Coronavirus Alleviation and Revitalisation of Enterprises Support (Ghana CARES) programme – centred on the economy and society and overlooked environmental solutions. For some stakeholders, Ghana CARES represented a business-as-usual approach, which would fast-track economic and, to a lesser extent, social recovery by focusing on economic consolidation as a buffer to future unanticipated events. It neglected environmental protection and sustainability.

While there was no consensus on a specific approach or path to take in responding to the pandemic, a clear appetite was expressed by interviewees regarding the need for development that considers the environment. Interviewees were also in agreement that Ghanaians generally have an appetite for green development. The need to go green has therefore become a matter of self-preservation.

"There is an appetite for green action": alternative policy responses to the pandemic and the climate crisis"

The interviews revealed five key areas where Ghana could both respond to the pandemic and to the climate crisis, which are described in more detail below:

1. Enhancement of economic opportunities for all
2. Expansion of social protection and health care services
3. Pursuance of vigorous green solutions as a new focus of development
4. Sustainable cities and infrastructure
5. Efficient energy supply

Enhancement of economic opportunities for all

The first area requires economic growth and financial sustainability in relation to the provision of jobs within a vibrant economy that enhances internal production of goods and services and reduces reliance on imports, especially food. One example would be improvements in food production systems through smart technologies to ensure efficient production, which could be done alongside enhanced access to agricultural extension services. Interviewees argued that boosting industrial growth would lead to job creation, particularly for young people, thus reducing unemployment.
The creation of industrial centres and hubs throughout Ghana would be one way of expanding employment opportunities and driving economic growth. It was further argued that a strong industrial base would eventually lead to Ghana transitioning to a middle-income country.

Expansion of social protection and health care services

Improving the responsiveness of the state to vulnerable and marginalised groups was highlighted as a key expectation for the future. Participants highlighted the need to expand the inclusion criteria for the Livelihood Empowerment against Poverty Programme (LEAP), and to generally improve social justice by bridging inequalities. Allied to this expectation was the enhancement of the National Health Insurance Scheme at the community level to reduce implementation challenges. According to stakeholders, this would require an injection of resources - particularly to improve access to healthcare services in hard-to-reach areas of the country where infectious diseases, such as Guinea worm and Buruli ulcer, are endemic.

Pursuance of vigorous green solutions as a new focus of development

Participants argued that education – at all levels of national development – was an essential first step to generating support for and implementing green policy solutions. This was not just to be aimed at children and young adults, but also focused on rural communities and vocational groups, especially farmers. It was highlighted that only through improved education and sensitisation towards climate change and its impacts would attitudes change and support for climate mitigation and adaptation measures being enhanced.

Participants also highlighted the activities of the Ghanian Forestry Commission and the Wildlife Society to establish green belts in order to reduce poaching of endangered species and encroachment into and destruction of wetlands. This will require strengthening existing institutions to improve the enforcement of forest protection and conservation laws. Reducing the drivers of deforestation, specifically the demand for biomass for cooking, was also discussed, with LPG and improved cookstoves highlighted as feasible solutions for urban and rural consumers respectively. Closely linked to this was the need to promote the planting of trees and support for backyard farming.

A number of other issues were also mentioned under this theme, including the elimination of illegal mining through enhanced income generating activities in rural communities; investments in early warning weather systems through climate finance; and cultivation of crops tolerant to changing climatic conditions. The latter was thought particularly important to encourage younger people to enter into and maintain an interest in farming. Participants, however, emphasised that the adoption of green solutions would require (financial) incentives, particularly for industrial adopters.

Sustainable cities and infrastructure

A growing urban population meant that, for many interviewees, increasing the availability and affordability of housing is a priority for Ghana. This was closely tied to government investments in affordable housing infrastructure in large cities and towns such as Accra, Kumasi, Takoradi, and emerging ones. Alongside access to affordable housing, participants argued these necessitated improvements in services, such as street lighting, water and sanitation, and waste collection and treatment – especially in informal settlements. It was emphasised that the delivery of essential holistic social services to informal settlements was particularly important to enhance the quality of life and life expectancy.

Improving the country's road infrastructure was also highlighted by participants, in particular, to reduce accidents and flooding – the latter being exacerbated by inadequate draining systems which will likely worsen with climate change. Participants highlighted the use of flyovers at busy intersections and the introduction of smart traffic control systems.

Efficient energy supply

Energy supply was an important concern for all experts; one which, if not addressed, would dampen economic progress. One area in which improvements were expected was improved management and investment in transmission and distribution systems. Alongside this, and to reduce pressure on the grid, participants argued for greater investment in off-grid production, including solar powered generation. Improvements in energy production, transmission and distribution was expected to lead to increased reliability and affordability for end users – both residential and industrial.

It was noted that to improve efficiency and eliminate systemic challenges, there was a need to overhaul the management of both the Electricity Company of Ghana and Ghana Grid Company. Participants argued that these institutions should be relieved of political influence and interference to enable people with the requisite technical capacities to take control. It was argued that this would lead to a greater sense of responsibility towards end users, especially with the constant presence of advocate groups, CSOs and research institutions to demand quality service delivered.

3. Scenarios for a greener recovery

Scenarios are tools which can help to improve decision making in respect of an uncertain future. Scenarios can help inform strategic decisions, improve resilience to uncertain external risks, and contribute to building consensus amongst diverse social actors.

In this project, we undertook a mixed-method participatory scenarios process, built around the question: "*How can long-term social and economic development priorities, and near-term recovery from Covid 19, be integrated with climate change policies in Ghana?*" The scenarios have a decadal timeframe, looking out to the year 2057, the 100th anniversary of the founding of the state of Ghana. In scenario development workshops with experts and key stakeholders, a consensus emerged around 15 strategic priorities that would serve as the basis for a socio-economic and green transformation. These were:

1. Increase investment and supply in clean energy sources
2. Expansion of industries in green technology
3. 100% achievement of basic education
4. Investment in early warning weather systems
5. Climate smart agriculture
6. Increase access to health infrastructure and the number of personnel and improved service for all
7. Preservation of useful cultural practices and sensitization of attitudinal change
8. Improve research on all sectors of the economy
9. Increase momentum on access to clean energy and efficient technologies for cooking purposes
10. Climate smart infrastructure
11. Increase social protection and insurance for the poor and vulnerable
12. Promote innovation and capacity for additional and alternate livelihood strategies
13. Institutional strengthening for the enforcement of laws/policies
14. Create social and economic opportunities and secured environment for investment to bridge regional imbalances
15. Public-private partnerships for investment

The 15 priorities provided an underlying framework of values which were viewed by stakeholders as common to any plan about how to move forward. Any scenario explored must address these priorities. Nonetheless, there are different ways of addressing such priorities. Based on the priorities, two scenarios emerged. The scenarios explore the implications of combining the 15 priorities with different rates of society-wide decarbonisation. Two scenarios were proposed: the *Leapfrog* and *Blended* decarbonisation scenarios.

In a *Leapfrog* scenario (Figure 1), a clear commitment to move away from fossil fuels and decarbonise the economy, is used to help leverage international funding and climate finance to support the transition. In order to avoid this leading to donor dependency, all international partnerships, whether involving financial or in-kind transfers, are carefully assessed to ensure they contribute in the long-term to internal wealth and job creation. The green economy, therefore, becomes a key economic driver.

Figure 1: Snapshot of Leapfrog scenario in 2057

Economic	Oil and gas activities are phased out. Long-term skills and R&D programmes, including a National Research Institute, and regional green manufacturing hubs, help diversify the economy and reorientate it towards high-skilled green jobs.
Social	Full coverage of basic services in health, water and sanitation, education services, in urban and rural areas is achieved. Clean cooking through domestically manufactured electric stoves. Roll out of basic services initially financed by international donor support and remaining O+G revenues. As the green economy develops, a sustainable fiscal revenue based is developed, avoiding donor dependence.
Energy and other infrastructure	Largely renewable electricity generation system with high local manufacturing content, including both large scale and distributed generation, and storage. Integrated transport infrastructure, including road, electrified rail, EV charging, and walking / cycling infrastructure. All infrastructure investment plans to pass climate resilience test.
Environment and land use	A climate smart-agriculture plan that takes account of agro-ecological zones and future climate change to promote resource efficient irrigation and appropriate crop choice. Land zoning policies ensure that biodiversity, carbon sequestration and climate resilience objectives are optimised. Investments in early warning systems.
Government	Internationally, the government makes a case for the leading ambition of the "Leapfrog" plan, to leverage direct funding, including through carbon markets, or long term patient finance, as well as knowledge transfer.

This scenario seizes the opportunity of the green transition, to generate jobs and wealth within the country rather than buying in technology produced elsewhere. In order to do this, it requires a strategic approach to education, connected with an innovation strategy that links early-stage research with development, deployment and commercialisation, with a National Research Institute playing a crucial role in this. Innovation is central to ensuring that Ghanaian businesses are well-placed to respond to the market demands that will be created by the green transition, and the Leapfrog scenario describes the importance of creating a diverse "ecosystem" of small, medium and large companies within all regions of the country, in order to create alternative livelihood strategies for those who are required to transition out of unsustainable forms of employment.

Figure 2: Snapshot of Blended scenario in 2057

Economic	Foreign direct investment has helped build manufacturing hubs across the country, in automotive and other sectors. FDI has also supported the expansion of oil and gas production, including new Petroleum Hubs. The fiscal regime ensures societally beneficial investments are extracted from O&G revenues, through a sovereign wealth fund. Through such industries, Ghana is a diverse and high skill economy. Green technology manufacturing is emerging in certain niches, and there is growing demand for imported green technologies.
Social	Full coverage of basic services in health, water and sanitation, and education services, in urban and rural areas is achieved. Fiscal revenues from O&G provide funding support for such services. Clean cooking is achieved primarily through LPG
Energy and other infrastructure	Domestic O&G supplies the internal energy system, and generates export revenue. There is a diverse electricity generation mix, including fossil fuel and some low carbon sources. An expanded transmission grid enables full electricity access and cross-border trading. Investment in road infrastructure, incremental improvements in vehicle emission standards, and incentives to support purchase of vehicles with local manufacturing content.
Environment and land use	A climate smart-agriculture plan that takes account of agro-ecological zones and future climate change to promote resource efficient irrigation and crop choice. Agricultural productivity is increased in part through fertiliser which can now be produced as part of the Petroleum Hub. Investments in early warning systems.
Government	Established partnerships with private sector, including foreign / multinational companies to facilitate O&G and other large infrastructure investments.

In the *Blended* scenario (Figure 2), the decision is taken to continue to invest in fossil fuel industries, using resource taxes to ensure that the wealth is spread fairly and to generate funds for public investment in crucial social services. The intention is for these industries to be phased down where possible, but not that they should necessarily be phased out via the most direct route possible. Decisions taken in pursuit of the fifteen strategies prioritise development above decarbonisation. The internal low carbon transition does proceed, but more gradually than in *Leapfrog*. In the power sector renewable investments occur alongside new gas and nuclear power stations, and in transport incremental tightening in regulations to improve vehicle efficiency occurs. Drawing on multiple energy sources Ghana becomes an energy hub for the West African region.

In this scenario there is some increased investment in clean energy sources, and expansion of industries in green technologies, but these are achieved incrementally, rather than through a direct or radical transformation. Sustained development of fossil fuel industries is used to generate revenues for investments in basic social services and in energy system infrastructures. Green energy technologies take a moderate share in power generation, alongside fossil fuels, and towards the end of the scenario period, as green technologies develop globally, foreign direct investment in Ghana's manufacturing helps to support emerging green industries and create jobs.

Both of these scenarios address the key concerns of the stakeholders, but they follow a different path in respect of the pace and depth of decarbonisation. A comparison of the scenarios helps to highlight some important areas for reflection, in relation to Ghana's way forward.

Resilience

Resilience is an important characteristic of any system. The scenarios provide reminders of several dimensions of resilience to be considered strategically in the context of future risks.

Large-scale infrastructure investments should be critically examined for their climate resilience. For example, large hydro and fossil fuelled thermal power may be vulnerable to water supply constraints, and electricity transmission infrastructure is vulnerable to heat. The power mix of *Leapfrog*, with higher contributions from solar PV, is less water-reliant and likely to require less large-scale transmission infrastructure. It may therefore be more resilient than *Blended* in this regard.

Economic resilience can also be enhanced through economic diversification, with activities in manufacturing, services and tourism, as well as industry. Climate-smart planning in agriculture, forestry and fishing is crucial to support livelihoods.

Climate policy resilience is also important. The success of *Blended* is contingent upon a long-term buoyant market for fossil fuels. However, if the world achieves a Paris-contingent emissions reduction trajectory with a resulting reduction in global fossil fuel demand, *Blended* would have a high risk of stranded fossil assets, whereas *Leapfrog* would be better placed to seize opportunities in green technology sectors.

Where's the money? Long-term sustainable finance, and global interactions

The two scenarios call for different approaches to finance and funding, with different implications both in the short and longer term. However, in both scenarios, partnerships and interactions with international actors are crucial.

Blended's strategy of continuing to invest in fossil-fuel-based systems and industries calls for relatively familiar partnerships with multi-national companies and institutions to secure finance for the continued oil and gas exploration investments. However, it still may incur government debt for investment.

The more transformational nature of *Leapfrog* may require more innovative approaches to securing near-term investment, as a result of its strong decarbonisation approach. Partnerships could support the transition through patient finance, funding from carbon credit markets, or in-kind support, such as technology and knowledge transfer. The climate leadership shown by Ghana in this scenario may create greater negotiating power to leverage such opportunities within UNFCCC frameworks.

In either case, partnerships should not simply replicate debt traps and donor dependence but lead towards self-reliance in the long term.

Ensuring broad-based development

In either scenario, conscious efforts should be made to ensure that economic growth is broad-based, and not overly skewed to certain sectors. This could be achieved through the fiscal redistribution of resource rents for broader social investments, and through fostering a diverse economy with strong contributions from several sectors. These could be distributed in different parts of the country, for example through regionally appropriate climate resilient agriculture, and regional manufacturing hubs. Community cooperatives can help support and reduce environmental and social risks associated with work currently carried out within the informal economy.

Governance and trust; short-term priorities and long-term planning

Any future development scenario must be underpinned by good governance and trust in political institutions. This includes financial transparency, clear conflict of interest rules and independent monitoring of public interest investments.

Increasing democratic participation within local decision-making, including coordination between local and customary authorities, will make an important contribution to accountability.

A long-term sustainable transition also requires politics that can engage both with short-term priorities and long-term strategic planning. There is an important balance to be struck between the desirability of long-term consistency, and the fundamental right in a democracy of an elected government to determine its own legislative programme, without being bound by those of previous administrations.

There are examples of national-level laws that create a clear long-term direction of travel but without overly constraining the right of any government to enact a distinctive programme – for example, the UK's Climate Act or Germany's *Energiewende*.

Scenarios can also play a similar role. Whilst not everyone may agree about every aspect of either of these scenarios, they provide a starting point for a discussion that clarifies certain elements of a future transition about which there is cross-societal consensus. This could contribute to a common ground for discussions within the country, as well as providing greater clarity and certainty to external actors, which may assist with unlocking finance and other forms of international cooperation.

4. Implications for energy and transport sectors

To quantify the implications for the energy system of the Leapfrog and Blended scenarios, we have developed the Ghana OSeMOSYS model. The Open Source Energy Modelling System (OSeMOSYS) is a modelling platform for exploring the evolution of different energy system futures to meet specified energy service demands (Howells et al., 2011). It can provide insights for the different scenarios described above including the level of energy supply needed, the types of technologies that will be needed, the investment requirements of those future systems, and how this impacts the environment e.g., CO2 emissions. It uses a linear optimisation approach to determine the least cost pathways, considering policy objectives and other factors e.g., resource and technology availability.

This particular version of the model builds on the starter model, referenced in (Allington et al., 2022), and has been developed to improve the representation of energy service demands and supply technologies as appropriate for Ghana (see Figure A1 in the appendix for an overview of model structure). An earlier version of the model was used to explore the required investments to deliver Ghana's GH-NDC (Cronin et al., 2021). In addition to the two main scenarios, a Reference case has also been modelled, which provides a further basis for comparison. It represents a continuation of current trends in respect of underlying drivers of energy demand, such as economic growth and demographics, and the mix of energy used to supply demand.

As reflected in the narratives, there is effective action towards cleaner cooking in both *Leapfrog* and *Blended* scenarios, while Reference sees the continued reliance on traditional biomass (Figure 3). In *Leapfrog*, there is a stronger focus on e-cooking and biogas, with no traditional biomass use by 2050. Blended focuses on a liquefied petroleum gas (LPG) strategy as a route to cleaner cooking, with some continued use of traditional biomass, although at a much lower rate than in *Reference*. The shift towards more efficient use of energy (away from biomass) helps moderate the overall increase in energy, driven by a threefold increase in the total number of households by 2050.

For lighting and cooling services, both *Blended* and *Leapfrog* see faster and higher levels of electrification but manage to moderate a big increase in electricity demand through stronger uptake of efficient appliances. The overall energy consumption in 2050 under the two scenarios of focus is much lower than in the Reference case due to the much more efficient use of energy because of lower levels of biomass use.

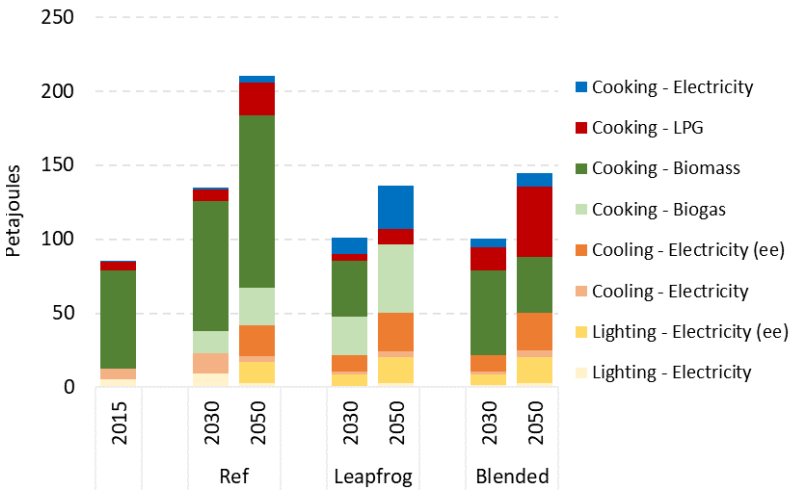
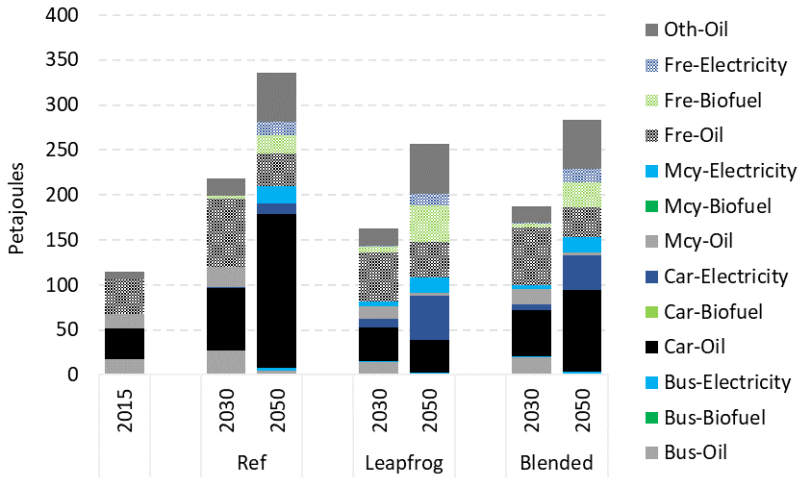


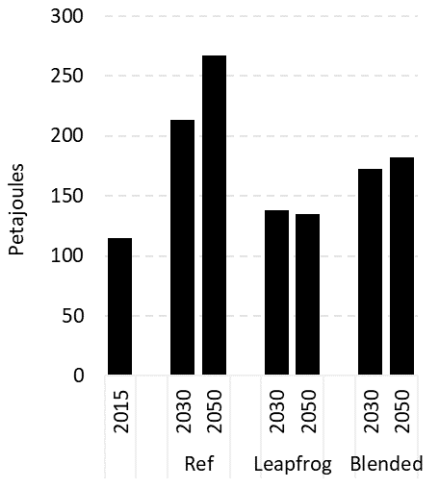
Figure 3. Final energy consumption by household energy type.
Note that 'Electricity (ee)' refers to more energy efficient appliances.

In all the scenarios, the transport sector experiences strong growth in mobility demand, and energy requirements over coming decades (Figure 4a). For car transport, this is projected to be a five-fold increase by 2050 (Figure 5). This means moving from a situation where 1 in 12 people have a car (Zambang et al. 2020) to 1 in 4 people owning a car (compared to 56% average in Europe).[1] The *Reference* case sees an oil dominated sector, with only small levels of e-mobility by 2050. In contrast to this, oil consumption in *Leapfrog* increases marginally from current levels, despite strong mobility growth, with electricity and biofuels being the key sources of energy in 2050. However, relative *Reference*, consumption of oil is half in *Leapfrog*, which results in much lower future dependence in per capita terms (Figure 4b). Overall energy use is some 30% lower in 2050 due to more efficient vehicle technologies, and a small increase in active travel reducing mobility demand. *Blended* follows a similar transition, but at a slower pace. This difference in pace of transition is illustrated in Figure 5 for passenger cars.

Figure 4. Final energy consumption in the transport sector by a) vehicle-fuel type and b) sector oil consumption. In panel a), 'Mcy' is two-wheelers 'Fre' is road freight, and 'Oth' is non-categorised transport.



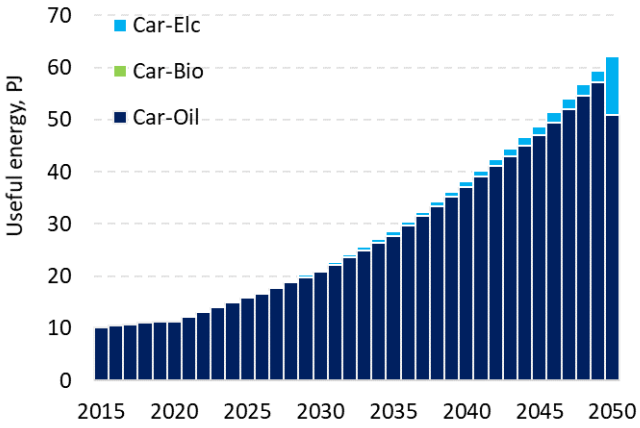
a)



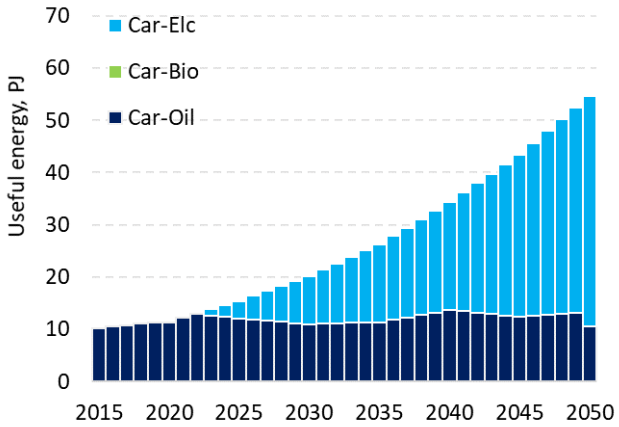
b)

1 Motorisation rates in the EU, by country and vehicle type, https://www.acea.auto/figure/motorisation-rates-in-the-eu-by-country-and-vehicle-type/#:~:text=The%20European%20Union%20counts%20560,Latvia%20the%20lowest%20(353).

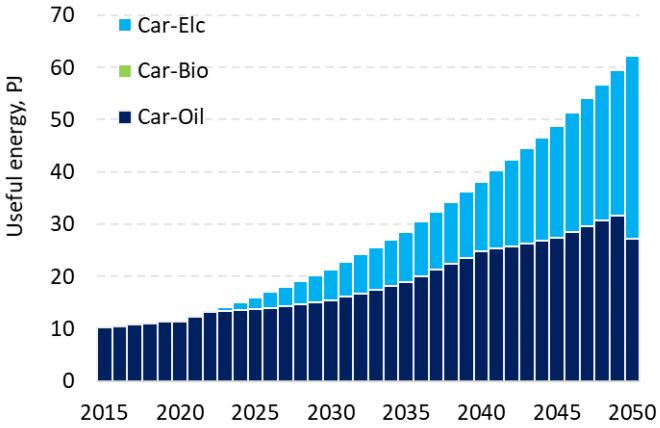
Figure 5. Useful energy demand for passenger cars, 2015-2050. This metric of 'useful energy' is a proxy for energy services needed to meet car demand, and is the energy delivered for mobility after efficiency losses have been accounted for.



a) Reference



b) Leapfrog



c) Blended

To meet this growing demand for electricity across the economy, generation levels are approximately 8 times higher than current levels in 2050. This requires large-scale expansion of renewable generation across all scenarios (Figure6), particularly as electricity demand rapidly increases during the 2030s. Even in the *Reference* case, where we assume a relatively low target share of renewable generation, renewables come through as cost-effective relative to other forms of generation, with wind and solar dominating the mix, and a key role for storage technologies to ensure grid integration of renewable plants. Some gas generation is retained in *Leapfrog* in 2050 to provide flexible load following plant but provides a higher share of generation in *Blended* and *Reference*.

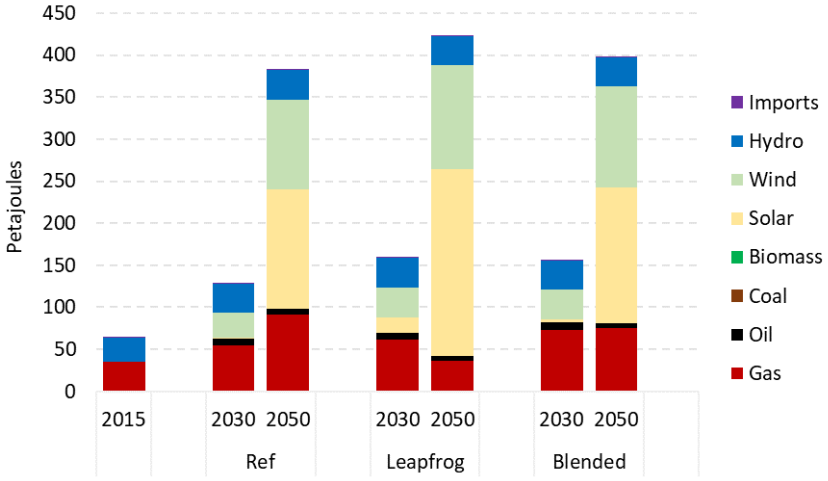


Figure 6. Electricity production by generation type. Renewable electricity share targets of 35%, 60% and 90% in 2040 have been implemented in *Reference, Leapfrog and Blended* respectively. These target values translate the prospects for low carbon electricity outlined in the narratives (in section 3). In Reference, this target share is exceeded due to the cost-effectiveness of such technologies in these scenarios.

The required investment for the growth of the generation system is shown in Figure 7. It highlights a 6-fold increase by 2050 under *Leapfrog* and *Blended* scenarios, and the importance of investment in the sector over the coming decades to meet Ghana's growing electricity needs.

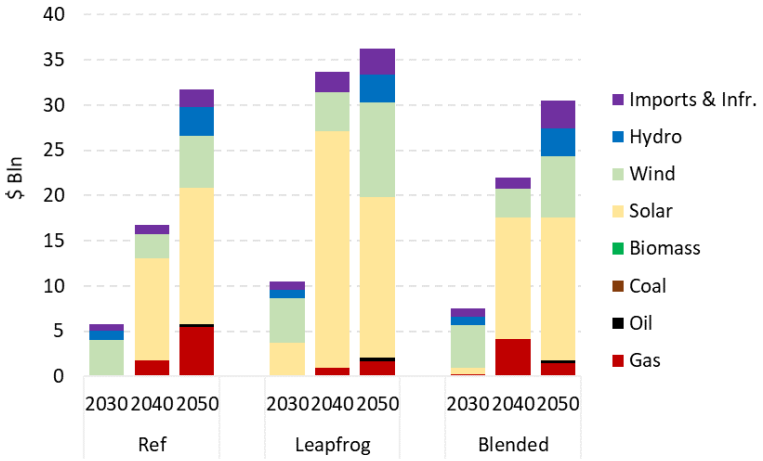


Figure 7. Electricity generation capacity investment (cumulative over 10 yr periods). Each year represents the cumulative investment for the previous 10-year period e.g. 2030 represents 2021-30. 'Infr' stands for Infrastructure.

Primary energy demand is the smallest in *Leapfrog*, with growth in demand moderated in end-use sectors such as transport and households by efficiency gains and other energy reduction measures (Figure 8). To a lesser extent, this is also seen in *Blended*, with lower biomass use; however, the relative share of fossil fuels is much higher than in *Leapfrog*. The *Reference* case sees strong growth in biomass by 2050; however, there is uncertainty as to whether Ghana could see such levels of growth in this resource in the future, given current sustainability concerns.

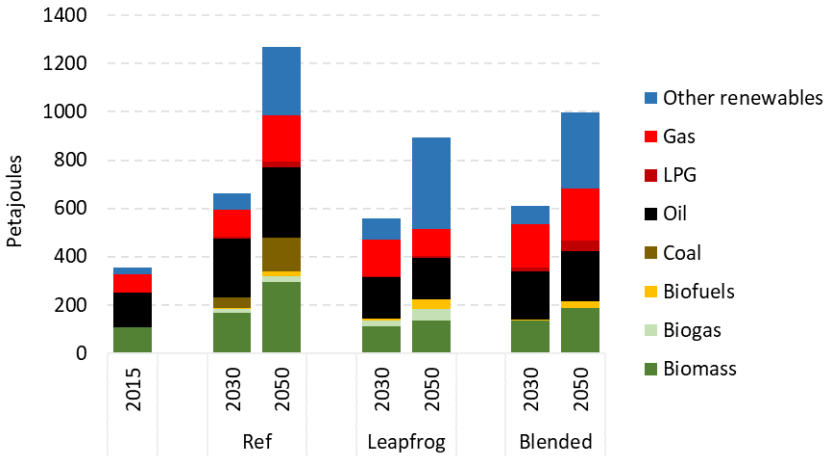


Figure 8. Primary energy consumption. 'Other renewables' includes wind, hydro and solar PV, and is based on the physical energy content method for primary energy accounting.

The lower levels of energy demand and lower carbon intensity of *Leapfrog* results in very low CO_2 emissions from the energy system, both in absolute and per capita terms. In absolute terms, emissions in 2050 are only slightly above current levels despite strong population and economic growth (Figure 9a & b). Therefore, on a per capita basis, emissions fall to well below current levels, at 0.4 tCO_2 per capita (excluding biomass, Figure 9d). This contrasts with *reference*, which sees emissions growth albeit to a level that is still very low in global terms. The *Blended* case sits between the *Reference* and *Leapfrog* case.

Due to the assumed low sustainability of much of the biomass use[2], Figures 9a-d both include and exclude emissions from biomass. However, this does not change the overall pattern across the scenarios. Based on the analysis by Cronin et al. (2021), *Leapfrog* leads to emissions well below the conditional NDC target, and *Blended* is much lower than the unconditional target (Figure 9b).

The GH-NDC was updated in 2021 (EPA/MESTI, 2021) and sets out the potential cumulative reductions of all GHGs over the period 2020-30. Reductions of 24.6 and 64 MtCO2e are proposed across all sectors, for unconditional and conditional targets respectively. For the conditional targets, approximately 19 MtCO2e of reductions are based on energy sector measures, with the remaining larger share from waste and forestry management. The estimate for energy sector measures in the unconditional target is not clear.

Cumulative reductions under Blended and Leapfrog for 2020-30 (relative to the Reference case) are estimated at 7 and 22 MtCO2 respectively (excluding biomass). This suggests that under Leapfrog, emission reductions are slightly higher than the conditional target. The Blended case is more likely to in line with the unconditional case, although we cannot state that with certainty. If we include reduced CO2 emissions from biomass, the reductions under Blended and Leapfrog are substantially higher, at 31 and 47 MtCO2 respectively, highlighting much larger gains if biomass CO2 is included (which it is not in the Ghana inventory).

2 CDM guidance - Fraction of non-renewable biomass (fNRB)
CDM: Fraction of non-renewable biomass (fNRB) (unfccc.int)

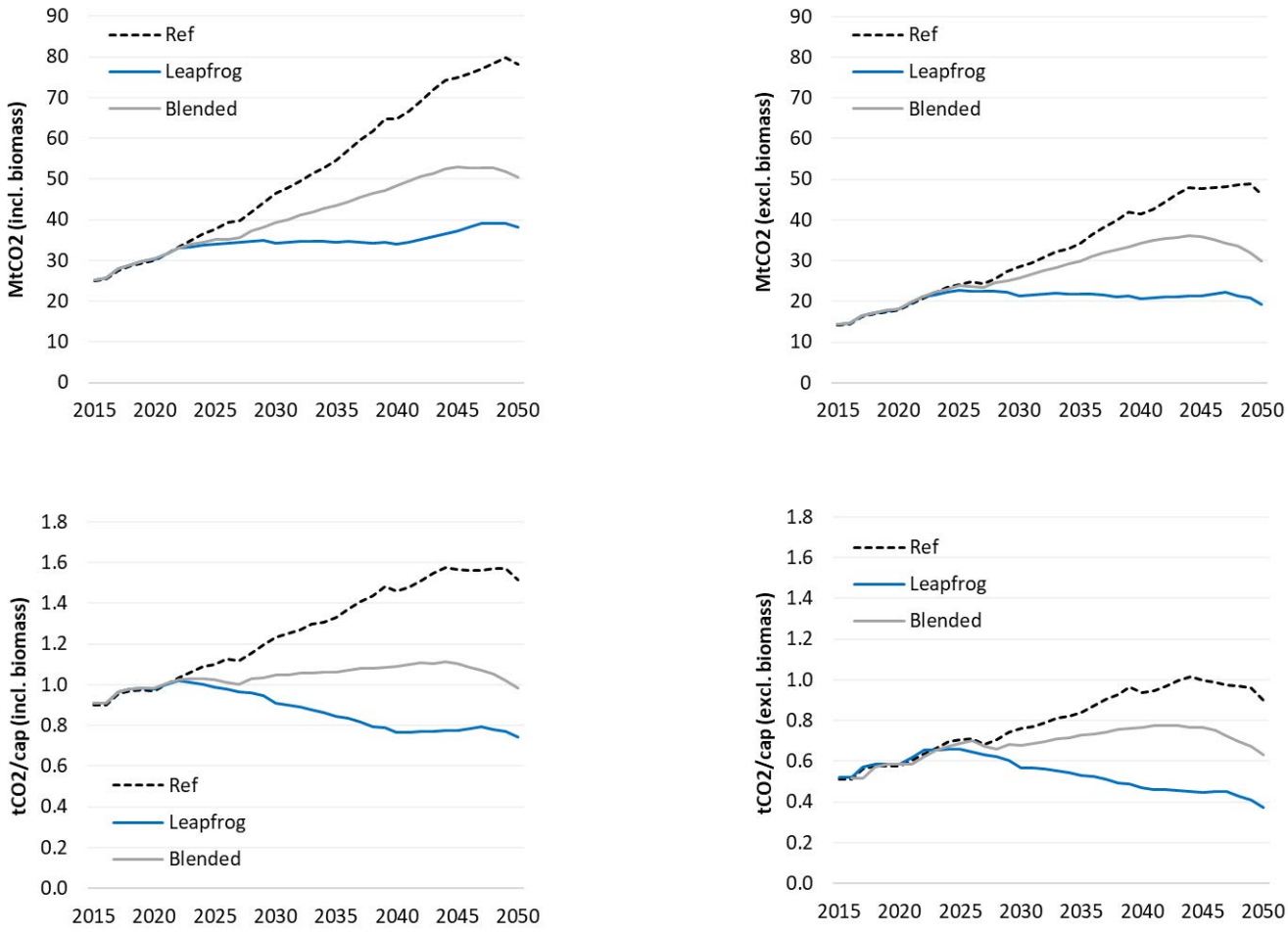


Figure 9. Energy sector CO2 emissions a) including biomass and b) excluding biomass, and per capita emissions c) including biomass and d) excluding biomass, 2015-2050. An assumption is made that the fraction of non-renewable biomass (fNRB) is at 99% based on information from the IPCC's CDM guidance.

Key insights

- There are different strategies for transitioning to cleaner and lower carbon forms of energy service provision, for example to provide clean cooking, and to reduce dependency of oil for mobility in the transport sector.
- A key part of this is electrification of these energy services. However, this is reliant on the provision of affordable and reliable electricity from a system that has to rapidly expand to meet this demand growth.
- Growth in electricity generation can be met predominantly through renewable energy, notably solar and wind, which are more cost-effective than conventional fossil fuel based generation. However, further work is needed to explore integration of high renewable systems, based on more temporally disaggregated modelling that better represents system operation.
- Large investment is needed for providing access to clean energy over the coming decades, particularly in terms of electricity generation. Support for investment in renewable technologies will be important, allowing Ghana to avoid uptake of fossil fuel generation.
- A crucial insight is that Ghana can provide for future energy needs using low carbon energy whilst growing its economy, and reducing dependency on fossil fuels and biomass. In large part, this is possible through more efficient use of energy. This also has implications for the oil and gas sector, which would need to meet less domestic demand.

5. Policy recommendations

The scenario building processes with key stakeholders provided the space to assess critical options for a green recovery agenda for Ghana. While both the '*Blended*' and '*Leapfrog*' scenarios bode well for sustainability in Ghana, the former should be embraced in the shorter term. The process, however, should integrate the salient elements of the 'Leapfrog' scenario that are compatible. Broadly, a 'Blended' recovery pathway is more suitable in the short to medium term (2022 -2030), followed by the rollout of the 'Leapfrog' pathway in the longer term (2031 onwards). The views expressed by many stakeholders during the scenario workshops was that the 'Blended' approach provides the required foundations for the implementation of the 'Leapfrog' pathway. For instance, such an approach would help to reinforce the development of gender-sensitive strategic policy provisions. This would support the production of holistic human capital that enables both men and women to operate effectively and efficiently in all sectors: energy, industry, transport, agriculture, health, education, and others.

Indeed, a recommendation to approach the recovery process now through the 'Leapfrog' pathway would not be as compelling, given the dire economic conditions of Ghana at present. Since Ghana's present debt to GDP ratio is estimated to be close to 85%, the enabling resources and fiscal space are too weak to enhance recovery along the '*Leapfrog*' pathway at present. While embracing the '*Blended*' pathway for the recovery is advocated for the short to medium terms, we have seven recommendations to help ensure this pathway's success.

1. **Enhance the re-alignment of major development frameworks of the country towards a Green Economy paradigm**
   Within the framework of a green resilient recovery, underpinned by the '*Blended*' approach, it is essential to re-align major development frameworks of the country with the Green Economy (GE) paradigm of development. Fundamentally, the following major development frameworks of the country should have strong interconnections with Green Economy tenets: the four-year cyclical Medium-Term National Development Policy Framework (MTNDPF); the Coordinated Programme for Economic and Social Development Policies; and other long-term plans and policies such as the Ghana@100 Long-term Development Framework; and Ghana Beyond Aid. Without a firm shift in development orientation in these development frameworks, from the business as usual (brown economy) towards green economy, misalignment of investments is bound to take place, which will invariably slow down the green transition. Once the policy frameworks and plans are aligned with a green economy pathway, the enabling conditions will be created for investment that is compatible with both of our scenarios. A higher quantum of investment will be needed under the 'Leapfrog' pathway compared to the 'Blended' pathway.

2. **Restructure COVID19 recovery policies and programmes especially, the Ghana Covid-19 Alleviation and Revitalization of Enterprises Support (Ghana CARES 'Obaatampa' programme) to have a greater focus on green transformation**
   COVID19 recovery policies and programmes should support resilient development and the integration of green development. Thus, the Ghana Covid-19 Alleviation and Revitalization of Enterprises Support (Ghana CARES 'Obaatampa' programme) should be re-structured to have greater focus on green economic, social and environmental transformational features so as to be more impactful in terms of sustainability. This restructuring process is required because, while the three-and-a-half-year GH¢100 billion programme was set up to 'mitigate the impact of the COVID-19 pandemic and return the country to a sustained path of robust growth and to create a stronger, more resilient and transformed economy', it failed to address green businesses and green product development in its scope of actions. It has instead been targeted mainly at general businesses in the "open" market. Nevertheless, there were some green businesses, which were not necessarily in the "open" market, that were severely affected by COVID-19 but were neglected.

3. **Update the scope and orientations of existing policies relevant to de-carbonisation and sustainability to be in sync with the current realities of the COVID19 recovery**
While greening the focus of recovery programmes, existing policies in the country needs to undergo thorough review, to update their scopes and orientations to be in sync with the green economy agenda. Particularly, the Environmental and Sanitation policy, the Ghana National Transport policy, and the National Water policies should be reviewed and updated as a matter of urgency since they do not fully integrate environmental goals. The transport sector especially, requires a policy and an action plan that can bring a robust transformation in mass mobility via electric Bus Rapid Transit (BRT) systems, cable cars, and electric trains through enhanced investment. Similarly, in respect of environmental sanitation, a roadmap is needed for the development of engineered landfill sites in all the major cities and rapidly developing towns, for the effective treatment of the high volumes of domestic wastes being generated daily. In relation to the National Water policy, emphasis on rooftop rainwater and surface runoff harvesting, and the desalination process should equally take centre stage.

4. **Revamp and sustain existing green initiatives in Ghana**
A few green economy compatible initiatives at the national level are either in operation or being discussed. These include Bus Rapid Transport (BRT) and the extensively discussed electric transportation (rail and cars).

   The Ghana version of the BRT called *Aayalolo* Bus Service (ABS) was introduced in Ghana's capital city Accra, on the Amasaman to Accra Central Business District (CBD) transport corridor in 2016.
   At present, the initially dedicated lanes on both sides of the road are non-functional and the buses, therefore, use the normal lanes. Secondly, there has not been an expansion of this initiative beyond the existing ineffective one.
   The electric transportation agenda has equally been on the drawing board for several years. It is, therefore, imperative to revamp and upscale the BRT as well as quicken the implementation of the electric transportation drive, through investment.

5. **Instilment of harmony between all sectoral policies and green economy paradigm**
Inter-institutional collaboration through cross-sector harmonization of policies and the green economy paradigm are prerequisites to foster green growth. This inter-sectoral harmonization process will ensure that policies of different sectors are not counter-productive to the desired sustainability targets of others. For instance, in pursuance of promoting electricity for cooking and for mass transport to boost green development, a harmonious strategy is needed to ensure that the electricity needs of green industries are not compromised. Therefore, it is imperative that a coherent inter-sectoral strategy is developed to have sufficient low-carbon electricity for both cooking and transport needs.

6. **Development of innovative financing and incentivization packages for green initiatives**
The importance of funding to shore up a green recovery in Ghana cannot be overemphasized. Given the dire financial state of Ghana at present, the involvement of the private sector in funding green initiatives is indispensable. Therefore, the development of innovative financing schemes will contribute to securing private sector investments in the green recovery drive. These schemes include Public-Private-Partnerships (PPP), blended finance, the provision of incentive packages such as cashback schemes for off-grid renewable electricity generation at the household levels, carbon market opportunities, Performance Based Payment mechanisms, and guarantees and tax waivers for green initiatives in-country for industries and large organizations.

7. **Strengthen both the administrative and fiscal decentralised structures of Metropolitan, Municipal and District Assemblies and set evaluation benchmarks for them**
The flow of funds for investment in the green recovery agenda cannot take place in a vacuum. Formidable institutional structures are required since the implementation of policy actions in Ghana takes place at the Metropolitan, Municipal and District Assemblies levels. In consequence, it is essential to strengthen the administrative and fiscal structures of the local government structures at the Metropolitan, Municipal and District Assemblies. Without streamlining the institutional structures and providing the needed resources to mandated institutions to handle the implementation of green policy actions, such policy actions will not be implemented effectively. To ensure that there is judicious utilisation of resources for their intended purposes, the institutionalization of clear benchmarks for evaluating the effectiveness of such allocated resources must be set.
Complementing this process will be robust monitoring and reporting schemes.

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Appendix: Modelling process and assumptions

The process of implementing the narratives in the OSeMOSYS model is shown in Figure A1. The first step was to identify distinctive features of the narratives of relevance to the energy system. These can be split into two different categories of assumption to be parameterised; i) underlying drivers such as GDP or population that will impact on the projections of energy service demands, such as mobility, industrial production etc., and ii) specific assumptions related to technology and fuel assumptions in the model itself.

Once features have been selected and parameterised, these were discussed with the scenario narrative team to ascertain whether the implementation was correct, and whether all necessary features were identified. The scenarios were then run in the model to produce the relevant metrics around technology deployment, investment, fuel use and emissions.

Based on a review of the scenario narratives for Ghana, the key characteristics of the scenarios that impact the energy system were identified and parameterised for implementation in the model. In addition to ***leapfrog*** and ***blended***, a scenario called ***reference*** was also included, which essentially maintains historical / current trends.

Table A1 and Table A2 list the assumptions considered to reflect elements of the narratives. These are split into the two categories – exogenous drivers and model parameters (that determine the role of technologies and fuels in the system). Exogenous drivers (Table A1) refer to those that are used to estimate energy service demand projections. These time series, which are fed into the model, are needed to set the future level of demands which are then met by the system constructed in the OSeMOSYS model. Energy service demands include mobility services, household cooking and appliance use, and industrial processes. Table A3 provides a mapping of what drivers are used to project energy service demands. Model parameters (Table A2), on the other hand, are specific assumptions or constraints that are integrated into the model itself, to determine how the energy system itself configures to meet those energy service demands.

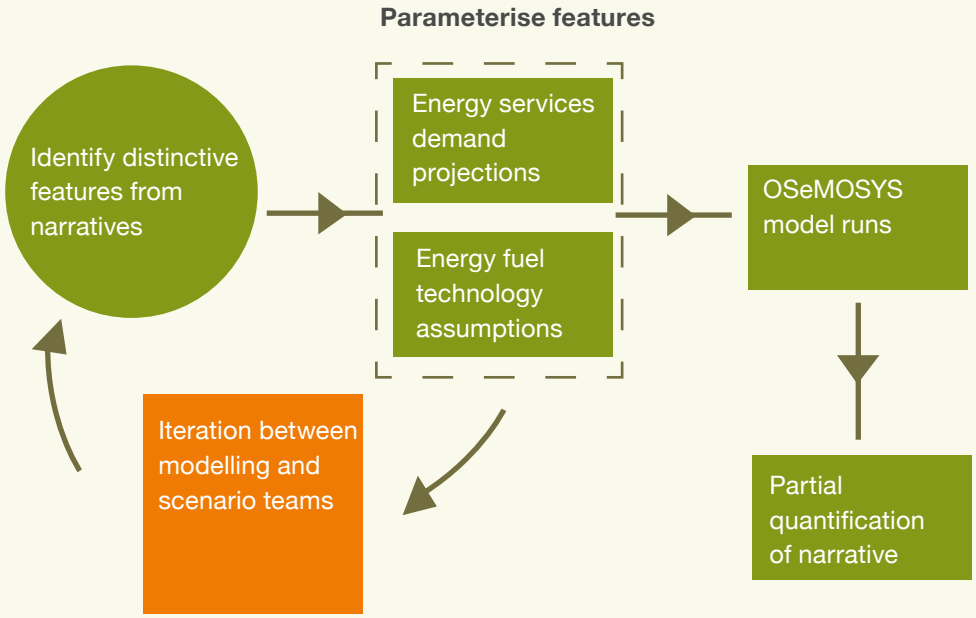


Figure A1. Scenario implementation in OSeMOSYS

Assumption type	Assumption	Reference	Leapfrog	Blended
Demographics	Population	Ghana@100		
	Urban population	Ghana@100		
	Household occupancy	Ghana@100		
Economy	GDP annual growth	2025: 7%, 2050: 5%		
	GDP shares by sector (Figure 9)	As per current shares	Ghana@100	Ghana@100
Household energy (lighting, appliances)	Electricity access (connectivity and use) (Figure 10)	Mid	High	High

Table A1. Drivers for energy service demand projections

Most of the exogenous drivers do not vary significantly between the different scenarios. Population, urbanisation and household projections are sourced from the Ghana@100 report (NDPC, 2019). GDP estimates are based on recent years of data, with the pre-Covid GDP growth rate between 5-6% (for a 5yr rolling average, 2015-2019). GDP rates of 7% by 2025 (recovering from 1% in 2020) gradually decrease over time as the economy expands.[1]
The structure of the economy follows Ghana@100 for both ***Blended*** and ***Leapfrog***, with a move towards a larger manufacturing sector, with agriculture's share dropping (Figure A2). ***Blended*** also sees a stronger role for the oil and gas sector, although this is relatively small in terms of contribution to GDP. Therefore, it is not explicitly considered here in these drivers but rather as part of the modelling of demand, where ***Blended*** sees more oil use than ***Leapfrog*** for example. Under ***Reference***, the current structure of the economy is maintained in future years.

The electricity access driver takes account of increasing electricity use for appliances – and sees both ***Blended*** and ***Leapfrog*** with higher levels of household usage compared to ***Reference*** (Figure A3).

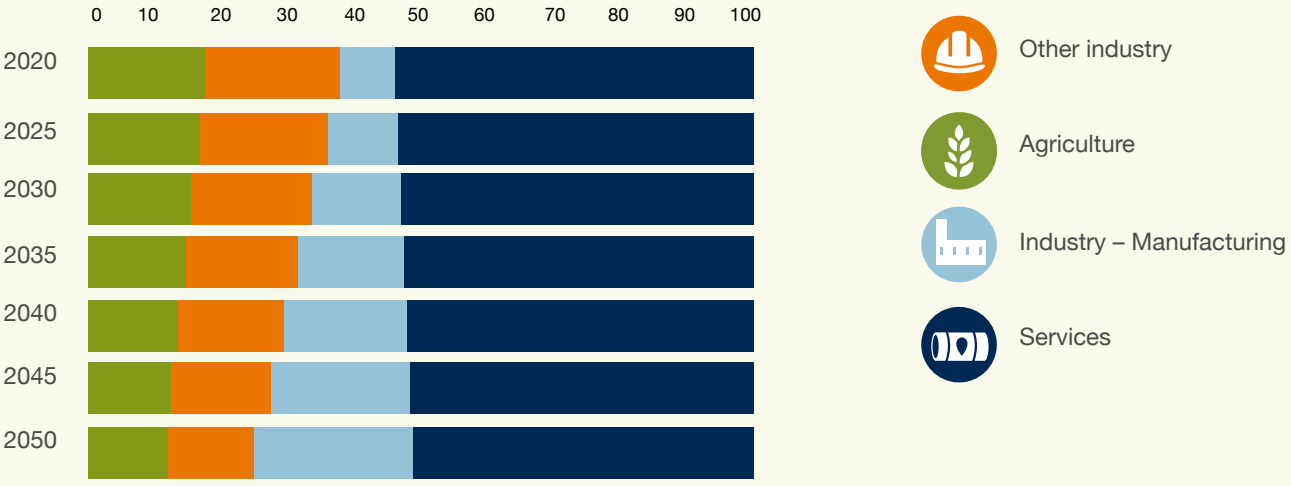
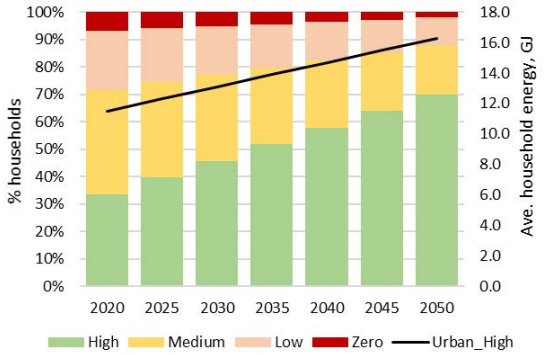
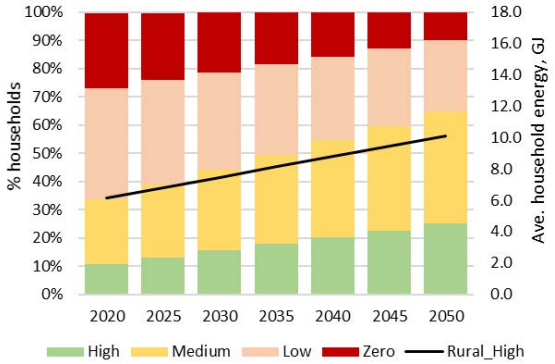


Figure A2. Sectoral contribution to GDP under Leapfrog and Blended scenarios. The Reference scenario in 2050 has the same share profile as seen for 2020.

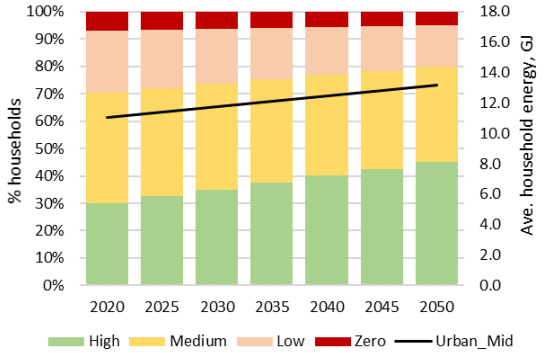
1 GDP estimates in Ghana@100 were not used as it was not possible to determine real GDP growth rates from the data provided.



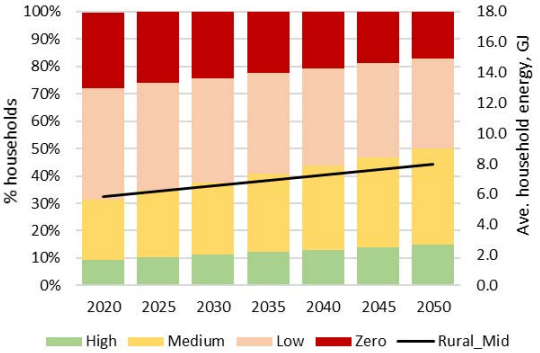
a) Urban – High (Leapfrog / Blended)



b) Rural – High (Leapfrog / Blended)



a) Urban – Mid (Reference)



b) Rural – Mid (Reference)

Figure A3. Household access to electricity, and level of use. The red bars indicate no access. Orange (low) through green (high) bars indicate increasing levels of consumption. The black trend line shows average household energy use, based on the shares of different household use levels.

It is through the model input parameters that the distinctions between the scenarios become more apparent. This includes minimum shares on renewable electricity generation, the level of e-cooking and the uptake of electric vehicles (Table A2). In power generation, in addition to different RES levels, we have also assumed no role for nuclear in *Leapfrog* but for some capacity to come online if it is deemed cost-effective in the other scenarios. In *leapfrog*, we also assume a 10% reduction in transport mobility demands (cars, buses, two wheelers) by 2040 due to the uptake of active travel.

Concerning the upstream fossil fuel industry, this has not been explicitly included in the model, despite being an important part of the narrative. This is because oil and gas commodities are traded internationally, and a national-focused OSeMOSYS model will not be able to provide meaningful insights on the import-export balance of such commodities, which will depend on rates of discovery and extraction, and the market prices. However, this forms an important part of the discussion based on changes to domestic demand in future years.

Table A2. Energy technology-fuel assumptions by sector

Sector	Assumption	Reference	Leapfrog	Blended
Power generation	RES level (2040)	35%	90%	60%
	Nuclear level	From 2040, nuclear could be installed (capped at 5GW)	No nuclear allowed	From 2040, nuclear could be installed (capped at 5GW)
Household energy	Cooking (2040)	60% Traditional biomass 10% e-cooking 30% LPG	0% Traditional biomass 65% e-cooking 20% LPG 15% Biogas	10% Traditional biomass 35% e-cooking 55% LPG 0% Biogas
Transport	Active travel (2040)		10% reduction in passenger demand across modes: cars / buses / 2W	
Transport	e-mobility share (2040)	5% across all passenger modes	60% cars, 80% buses, 80% 2W 30% freight	35% cars, 50% buses, 50% 2W 15% freight
Transport	Biofuels share (2040)		10% freight	5% freight

Table A3. Mapping of energy service demands to projections drivers

Sector	Energy service demand	Driver
Households (differentiated by rural/urban as needed)	Lighting	Households, household electricity access
	Cooling	Households, household electricity access
	Other appliances	Households, household electricity access
	Cooking	Households
	Heating, Other	Households
Commercial	Electrical appliance (inc. cooling)	Commercial GDP
	Heating	Commercial GDP
Industry (differentiated by manufacturing, other industry as needed)	Electrical appliances	Industry GDP - manufacturing, other
	High temp. heat	Industry GDP - manufacturing, other
	Low temp. heat	Industry GDP - manufacturing, other
Agriculture	Agriculture demand	Agriculture sector GDP
Transport	Passenger cars	Population, GDP / cap
	Passenger 2&3 wheelers	Population
	Passenger Bus	Urban population
	Freight	GDP
	Other Transport	GDP

ucl.ac.uk/bartlett/sustainable/research-projects/2021/sep/greening-recovery-ghana-and-zambia