# Assessing Costs and Benefits of Jamaica's 2050 Long-term Emission Reduction and Climate Resilient Strategy

## Final Report

2025

## About Climate Lead Group

Climate Lead Group provides state-of-the-art consulting services rooted in data and rigorous research, driving sustainable development and climate action. Climate Lead Group brings a wealth of experience, having coordinated, and developed over 20 projects in collaboration with multiple government agencies and international organizations.

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## About 2050 Pathways Platform

The 2050 Pathways Platform is a government and multi-stakeholder initiative launched at COP22 by then High-Level Climate Champion and architect of the Paris Agreement Laurence Tubiana. It was established at the request of countries who wanted a "big tent" approach to 2050 long-term climate strategies. In addition to countries, it brings together a network of bilateral and multilateral donors, international and national think tanks, and climate policy experts with an interest in long-term planning in response to the climate challenge.

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# Message from the Climate Change Branch: The Economic Case for Jamaica's Long-Term Strategy

Jamaica is at an important moment in its national development journey. As a small island developing state, we experience first-hand the impacts of climate change on our economy, communities, and natural environment. For Jamaica, it is no longer a distant risk, it is a lived experience. From Hurricane Melissa to the myriads of other climate shocks, we are reminded that recovery is not simply about rebuilding what was lost, but about strengthening resilience, protecting livelihoods, and safeguarding development gains for the current and future generations. We recognize that climate action presents a powerful opportunity to build a more resilient, inclusive, and sustainable future for all Jamaicans. It is in this spirit that I am pleased to introduce this report, Assessing the Costs and Benefits of Jamaica's 2050 Long-Term Emission Reduction and Climate Resilient Strategy.

The 2050 Long-Term Emission Reduction and Climate Resilient Strategy (LTS) sets out Jamaica's long-term vision for reducing emissions while strengthening resilience across key sectors of the economy. This cost-benefit analysis provides clear, accessible evidence to support that vision. It shows that taking early, well-planned climate action is not only essential for safeguarding our people and ecosystems, but also makes strong economic sense. The findings demonstrate that the benefits of implementing the LTS outweigh the costs over time, delivering gains such as improved public health, job creation, enhanced energy security, and reduced vulnerability to climate-related shocks.

Importantly, this report reflects a collaborative and inclusive process. Government agencies, technical experts, academic institutions, and international partners worked together to ensure that the analysis was grounded in Jamaica's national circumstances and development priorities. The use of transparent, open-source tools and capacity-building activities also strengthens our national ownership and supports informed decision-making beyond this study.

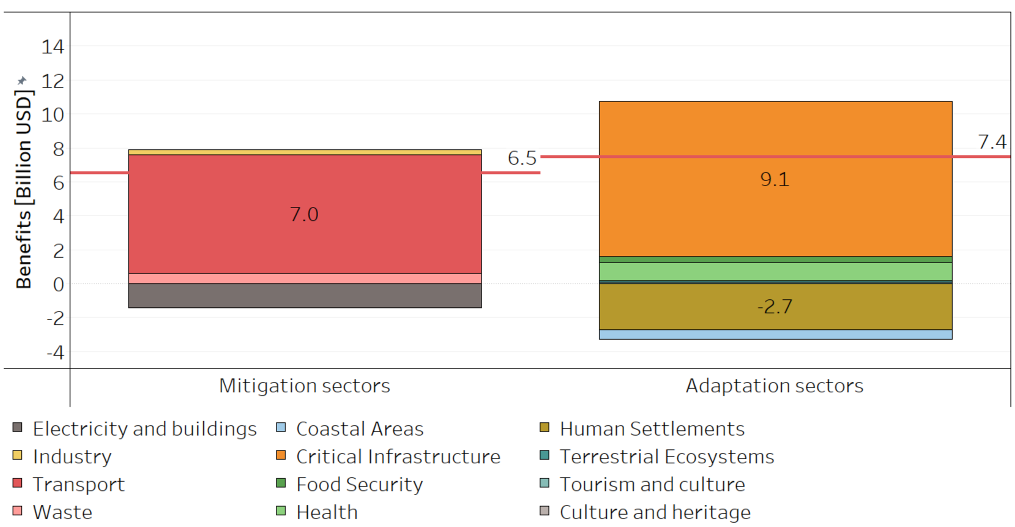
As Jamaica continues to turn plans into action, this report serves as a valuable reference for policymakers, stakeholders, development partners, and the wider public. It reinforces a simple but powerful message: investing in climate resilience and low-emission development is an investment in Jamaica's long-term prosperity, security, and well-being.

**Omar Alcock,** Acting Principal Director
Climate Change Branch, Ministry of Water, Environment and Climate Change

# Executive Summary

**Jamaica's 2050 Long-Term Emission Reduction and Climate Resilient Strategy (LTS) outlines a transformative pathway toward net-zero emissions by 2060 or earlier, while enhancing the country's resilience to climate impacts.** To support decision-making and implementation, a comprehensive cost-benefit analysis (CBA) was conducted to assess the economic feasibility and broader socio-economic implications of the LTS. This analysis covers both mitigation and adaptation actions defined in the LTS and compares outcomes against a business-as-usual (BAU) scenario over the 2025–2050 period. The analysis was developed using a participatory approach, that involved bilateral meetings, consultation workshops and capacity building sessions that informed the development of tailored sectoral OSeMOSYS-based models and macroeconomic KLEM model.

**According to the results, the LTS is cost-beneficial overall, amounting to US$13.9 billion[1] in net benefits under baseline assumptions.** The analysis demonstrates that the benefits of implementing the LTS exceed the costs, confirming the strategy's economic soundness. For mitigation actions alone, net benefits reach USD 6.5 billion. Adaptation actions also show positive net impacts in sectors such as food security, ecosystems, and tourism $7.4 billion net benefit across sectors)[2].There are multiple additional hard-to-quantify benefits that have been identified qualitatively in this report, including increased productivity from a more efficient transport system, reduced losses and damages resulting from implementing some specific actions, and the preservation of cultural identity through enhanced resilience of heritage sites.




The graph shows the difference between an LTS scenario and a BAU scenario for mitigation actions. Positive values represent instances where the LTS scenario has higher savings and benefits compared to the BAU scenario. For adaptation actions, the analysis shows the incremental benefits compared to a scenario where the LTS is not implemented.

**Figure E1. LTS cost-benefit analysis results.**

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[1] All costs referenced in this document are expressed in United States Dollars (USD)

[2] This analysis builds on the baseline assumptions and targets of the LTS. Then it tests their robustness across 100 potential future scenarios. Therefore, costs and benefits may vary with changing assumptions. However, the results consistently show that the LTS remains beneficial different assumptions.

**Most of the quantified mitigation benefits are concentrated in the transport sector and critical and infrastructure sectors**, driven by: savings from reduced fossil fuel consumption, lower vehicle maintenance costs, health benefits from reduced air pollution, efficiency gains from modal shifts and electrification and benefits of having more resilient water infrastructure that experiences less losses.

**Achieving the LTS requires understanding interdependencies between sectors.** For example, electrifying transport will increase power demand, making energy sector investments essential. However, energy efficiency improvements across sectors can lower overall electricity needs, making the transition more cost-effective.

**Several actions (e.g., climate-smart agriculture, sustainable waste management, and forest restoration) contribute to both mitigation and adaptation goals.** These synergistic strategies are valuable entry points for integrated climate planning and can help strengthen the adaptation narrative.

**Although only some of the benefits in the adaptation sectors can be quantified, the analysis confirms their importance.** Many of the evaluated strategies (e.g., reef restoration, improved housing, ecosystem conservation) provide long-term gains in resilience, health, and livelihoods. Additionally, this analysis identified that there are ongoing or planned national initiatives that can contribute to the implementation of the LTS adaptation goals: e.g., initiative to install fish sanctuaries, reduce water losses, install energy storage systems, water supply development strategies, among others.

**The analysis of future scenarios under uncertainty highlights the conditions that yield the greatest benefits from Jamaica's mitigation actions**. **Results show that boosting energy efficiency across all sectors, expanding renewable energy, promoting public transport, and limiting waste generation are critical to maximizing long-term gains**. To ensure cost-effective implementation, measures should be sequenced strategically, prioritizing energy efficiency early on to reduce future infrastructure costs and enable a smoother transition toward electrification. The findings suggest that fossil fuel demand should decline from ~83 PJ[3] in 2025 to 72 PJ or less by 2050, while renewables—mainly solar and wind—should supply at least 64% of electricity by 2050, consistent with the 100% renewable electricity target. A modal shift toward public transport (at least 35% of the transportation demand) and greater support for non-motorized mobility will further enhance the LTS's cost-effectiveness. Finally, keeping solid waste generation below 1.4 kg per person annually by 2050 would yield substantial economic and environmental savings.

**Implementing the LTS is projected to yield substantial macroeconomic benefits for Jamaica by 2050.** GDP is expected to rise 5.9% above the Business-As-Usual (BAU) scenario, driven by improved cost-benefit dynamics as major investments mature. Despite a temporary increase of 0.8 to 0.9 points in unemployment from 2025 to 2027 due to the consequences of front-loaded capital expenditures on overall prices, job creation rebounds strongly by 2030, ultimately generating approximately 26,000 additional jobs across 12

[3] PJ (petajoules) is a standard unit of energy measurement, where 1 PJ = $10^{15}$ joules

sectors, corresponding to a 1.8-point drop of the unemployment rate. The most significant employment gains are expected in Agriculture, Forestry, and Fishing, reflecting labour-intensive, adaptation-aligned investments. Household consumption and non-energy output also surpass BAU levels in the long run, reaching gains of 6.4% and 3.9%, respectively. Sectoral GDP gains are led by Government Services and Tourism-related sectors, such as Hotels and Restaurants, underscoring the LTS's potential to drive broad-based economic transformation.

**On the fiscal front, the LTS combines public and private financing**, with government covering about 80 percent of adaptation costs and 40 percent of mitigation investments. This raises public capital spending from 1.8 percent of GDP in 2024 to nearly 5 percent within the first decade. As a result, debt-to-GDP is projected to decline more gradually under the LTS, falling from 67.9 percent in 2024 to about 65 percent by 2050, compared to a sharper drop to 39 percent under BAU. This trajectory means the LTS on its own would not meet the legislated target of reducing debt to 60 percent of GDP by FY2027/28. However, once the upfront investment phase eases, growth is expected to accelerate, stabilizing debt at sustainable levels well below Jamaica's historical highs. With complementary fiscal measures, the LTS path can remain consistent with the government's debt reduction objectives while also delivering stronger long-term growth, productivity, and resilience.

**To maximize the benefits stemming from the LTS, the report recommends:** enhancing coordination among interdependent sectors, aligning national initiatives with the LTS, prioritizing high-linkage and labour-intensive sectors, and stimulating green job creation through training and incentives. Additional measures include leveraging private finance and international support, integrating climate goals into fiscal planning, front-loading resilient infrastructure investment, and managing fiscal risks responsibly. The analysis underscores the importance of social protection and workforce reskilling to ensure a just transition, as well as the need for further technical studies on renewable energy and adaptation targets to strengthen stakeholder ownership. Overall, the findings confirm that a well-coordinated, inclusive, and fiscally sound implementation of the LTS can deliver sustained economic growth, resilience, and climate benefits for Jamaica.

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# Acronyms

| | |
|---|---|
| BAU | Business-as-usual |
| CIRED | Centre International de Recherche sur l'Environnement et le Développement |
| CBA | Cost-benefit analysis |
| CCVA | Climate change vulnerability assessment |
| CLG | Climate Lead Group |
| CSA | Climate Smart Agriculture |
| EWS | Early-warning systems |
| GDP | Gross Domestic Product |
| IMF | International Monetary Fund |
| I-O | Input-Output |
| KLEM | Capital, Labour, Energy and Materials |
| LTS | Jamaica's 2050 Long-Term Emission Reduction and Climate Resilient Strategy |
| LPG | Liquified Petroleum Gas |
| MEGJC | Ministry of Economic Growth and Job Creation |
| NbS | Nature-based Solutions |
| OECD | Organisation for Economic Co-operation and Development |
| OSeMOSYS | Open Source energy MOdelling SYStem |
| PIOJ | Planning Institute of Jamaica |
| PRIM | Patient Rule Induction Method |
| RDM | Robust Decision Making |
| T&D | Transmission and distribution |
| USD | United States Dollar |
| UWI | University of the West Indies |

# 1 Jamaica’s pathway for low-carbon and resilient development

As part of its ongoing commitment to climate action, the Government of Jamaica, led by the Ministry of Economic Growth and Job Creation (MEGJC) and guided by a multistakeholder committee mandated by the Cabinet Office, co-chaired by Planning Institute of Jamaica and MEGJC introduced the 2050 Long-Term Emission Reduction and Climate Resilient Strategy (LTS) in 2023 (Government of Jamaica, 2023). This comprehensive strategy, developed with support from the 2050 Pathways Platform and funding from IKI, sets out Jamaica’s ambitious roadmap to reach net-zero emissions by 2060 or earlier and enhance climate resilience across all sectors. It establishes clear targets for the short, medium, and long term, and is closely aligned with the national development objectives set in the Vision 2030. Through its implementation, the strategy is expected to support Jamaica’s broader development goals of promoting well-being, ensuring security and justice, fostering economic prosperity, and protecting the environment (Planning Institute of Jamaica, 2009).

**Vision for Jamaica’s LTS**

Jamaica employs a **people-centric** approach **towards a net-zero, sustainable, and resilient development** that provides **quality livelihoods** and **improved health and well-being**, leveraging **opportunities** to benefit **all Jamaicans**.

## 1.1. Jamaica’s 2050 Emission Reduction and Climate Resilient Strategy (LTS)

The LTS outlines sector-specific transformations, directing mitigation efforts toward major emission sources—electricity, transport, buildings, agriculture, waste, forestry, and industry (Figure 1)—and focusing adaptation on the most vulnerable sectors, including tourism, coastal areas, terrestrial ecosystems, food security, critical infrastructure, human settlements, culture and heritage, and population and health (Figure 2). Reflecting their differences, adaptation and mitigation actions are structured differently in the LTS. Mitigation actions focus primarily on quantitative goals, while adaptation actions outline broader qualitative goals.

**Mitigation actions in the LTS**

**Electricity**

- ↑ Generate 27% of electricity from renewables by 2025, 50% by 2030, 65% by 2035, 90% by 2040 and 100% by 2050
- ↓ Limit T&D losses to no more than 25% by 2025, no more than 21% by 2030, 17% by 2035, 14% by 2040 and 8% by 2050
- ↓ Fully phase-out 100% Heavy Fuel Oil capacity by 2035
- ↓ Phase-out 100% of fossil fuel generation by 2040

**Transport**

- ↑ Electrify the vehicle fleet: *i)* Private: 8% by 2025, 12% by 2030, *ii)* Public: 10% by 2025, 16% by 2030, Deploy at least 2000 electric buses by 2040, *iii)* All: 67% by 2050
- ↓ Reduce trucks' fuel consumption by 40% relative to 2020 levels through efficiency improvements by 2050

**Buildings**

- ↑ Increase the share of households with solar water-heating by at least 60% by 2030 and 85% by 2050
- ↑ Lighting: *i)* Replace 100% of electric lighting in residential buildings with LED lamps, *ii)* Convert 100% of schools and hospitals from T12 to T8 lamps, and *iii)* Replace 100% of public and commercial buildings with LED equivalent
- ↑ Cooking: *i)* Replace wood, kerosene, and charcoal stoves with more sustainable option stoves by 2035, and *ii)* Phase out new LPG cookers, and reduce LPG use to 10% of 2020 levels by 2050

**Industry**

- ↓ Reduce clinker-to-cement ratio to 82% by 2025, and 70% by 2030
- ↓ Reduce fuel consumption for alumina prod. by 25% relative to 2020 by 2030
- ↓ Reduce share of coal for cement production from 89% in 2020 to 83% using recycled materials or biomass by 2040
- ↓ Reduce sectoral energy intensity by 15% relative to 2020 levels by 2050

**Forestry**

- ↑ Increase forest cover by 5% relative to 2020 by 2030, plus add. 3% by 2050
- ↑ Reduce deforestation and forest degradation rates by 30% relative to 2020 by 2030
- ↑ Increase mangrove cover by 4000 ha by 2050

**Agriculture**

- ↓ Reduce 14% of livestock emissions through sustainable land-use management and 20% of ruminant animal methane emissions relative to 2020 by 2030
- ↑ Deploy silvopastoral solutions with agroforestry on 10% of the total cropland with at least 27kt$CO_2$e annual sequestration

**Figure 1. Summary of mitigation actions included in Jamaica's LTS**

**Adaptation actions in the LTS**

| | |
|---|---|
| Food security | • Promote **climate-smart agriculture** integrating climate risk with food and nutrition priorities.<br>• Invest in **efficient irrigation systems** and build local capacity to manage drought.<br>• Support **crop diversification** by encouraging climate-resilient alternatives.<br>• **Control overfishing and protect marine food sources.**<br>• Expand **agroforestry and silvopasture** through forest restoration initiatives.<br>• **Conserve mangroves to secure fisheries, improve livelihoods, and mitigate climate impacts.** |
| Terrestrial ecosystems | • Improve **forest governance and biodiversity protection**.<br>• Scale up **afforestation, reforestation, and sustainable forest management**, including agroforestry practices.<br>• Establish **fishery conservation areas** using NbS approaches.<br>• Align **national forest strategies and conservation plans** with the LTS |
| Human settlements | • **Address informal settlement** vulnerabilities with inclusive housing programs.<br>• Promote **low-carbon cooling** solutions.<br>• **Provide microinsurance to support post-disaster recovery** and reduce financial exposure.<br>• **Protect critical assets** through sea walls and similar coastal defenses.<br>• **Implement managed retreat** from high-risk coastal areas. |
| Critical infrastructure | • Conduct **risk and vulnerability assessments** across infrastructure types.<br>• Apply **Nature-based Solutions** to strengthen critical systems.<br>• Develop **climate-resilient power systems** with improved design standards and renewable energy integration.<br>• **Upgrade water systems** to manage scarcity and sanitation, including reuse, storage, and flood protection.<br>• **Reinforce transport infrastructure** (roads, bridges, ports) through coordinated planning and resilient design. |
| Tourism | • Strengthen **coastal protection** with engineering and Nature-based Solutions (NbS), including beach nourishment and artificial reefs.<br>• **Improve land management** to reduce pollution from runoff.<br>• Develop and **diversify tourism offerings** to lessen pressure on coastal ecosystems, highlighting Jamaica's culture and nature.<br>• **Expand and enhance Marine Protected Areas** through robust policy frameworks.<br>• **Tackle overfishing** through better regulation and enforcement. |
| Coastal | • **Reduce erosion** via bioengineering and updated coastal laws.<br>• **Restore coral reefs** and expand reef-building efforts.<br>• **Conserve and restore mangroves and wetlands** for storm protection, livelihoods, and ecosystem health.<br>• Encourage **ecosystem service payment schemes** to fund conservation.<br>• Strengthen disaster preparedness through **early warning systems and coastal hazard planning.**<br>• **Reduce tourism pressure** through sustainable offerings and cultural/natural highlights. |
| Culture and Heritage | • **Safeguard cultural heritage with climate-resilient facilities** and risk management plans.<br>• **Document and preserve cultural knowledge.**<br>• **Increase youth awareness of Jamaican history** and cultural identity through education and outreach. |

**Figure 2. Summary of adaptation actions included in Jamaica's LTS.**

### 1.2. Jamaica's LTS cost-benefit analysis

To support Jamaica's decision-making for implementation and align the strategy with national development priorities, this project evaluated the costs and benefits of the country's LTS. It addressed both financial impacts—such as operational costs and required investments—and non-financial impacts—such as benefits related to health and ecosystem services. The analysis also explored the broader macroeconomic implications of implementing the LTS, particularly its potential effects on growth and employment at the national and sectoral levels.

To ensure a comprehensive understanding of how these costs and benefits are distributed across Jamaican society, the study incorporated diverse stakeholder perspectives. This engagement involved two participatory workshops, one session to present results and multiple bilateral meetings with key Jamaican institutions. Stakeholder feedback and existing national data were integrated into open-source modeling tools, which served as the foundation for the cost-benefit analysis. Capacity-building sessions were also conducted to train government stakeholders and university students in the use of these tools.

The project was led by the Climate Change Branch of the Ministry Name to Ministry of Water, Environment and Climate Change, supported by the 2050 Pathways Platform, and implemented by Climate Lead Group (CLG) in collaboration with economists from the University of the West Indies (UWI) and the French *Centre International de Recherche sur l'Environnement et le Développement* (CIRED).

The analytical approach consisted of three stages:

- First, sectoral models were developed using OSeMOSYS to assess the financial and non-financial costs and benefits of implementing the LTS (KTH-dESA, 2023). Two scenarios were created: *i)* a business-as-usual scenario that projects current trends, and *ii)* an LTS scenario that reflects the necessary transformations to achieve goals laid out in the LTS.
- Second, the macroeconomic impacts of the LTS were analyzed using the compact 2-factor, 2-sector KLEM model calibrated on Jamaican data and adapted to the modelling of the Jamaican economy (Ghersi et al., 2024).
- Finally, the results from the KLEM model were disaggregated to examine sector-specific effects and potential fiscal impacts, using Jamaica's most recent input-output matrix. The full methodology and model specifications are detailed in Appendix A.

### 1.3. Robust decision-making and the role of the participatory process

To evaluate the costs and benefits of Jamaica's existing LTS, the project employed a participatory approach that accounts for the impact of uncertainty on LTS outcomes. It incorporated input from local stakeholders to support the overall progress of the project, identify essential data sources, and determine the costs and benefits to be considered and highlighted in the analysis. The methodology used was Robust Decision-Making (RDM), a flexible and well-established framework that has been successfully applied in various contexts to help governments design or assess resilient policies. While the models create baseline scenarios, RDM recognizes the uncertainty in the assumptions and data sources used.

Therefore, it explores how the outcomes of the LTS may vary within that range of uncertainty by modeling the future evolution of baseline scenarios under a wide array of possible futures (The 2050 Platform and Climate Lead Group, 2024).

To assess the impact of mitigation actions, the first step involved developing two baseline scenarios using OSeMOSYS, an open-source tool. OSeMOSYS was calibrated with local data collected during the participatory process (e.g., the National Energy Balance, Integrated Resource Plan, Jamaica's Economic and Social Survey, and other national plans). The OSeMOSYS model focused on characterizing key elements of the mitigation sectors, particularly those most directly impacted by LTS actions. Subsequently, 100 possible futures were modeled, incorporating the uncertainties identified with stakeholders and their respective ranges of variation. This process informs the expected ranges of costs and benefits derived from LTS implementation.

Given the qualitative nature of adaptation goals, an additional step was necessary before assessing the costs and benefits of adaptation actions. First, the project aimed to connect the LTS's broader climate adaptation goals with specific plans, targets, and initiatives that sectoral entities are currently implementing or intend to implement. By breaking down these overarching objectives into more granular and actionable strategies, the economic impacts can be evaluated by aligning them with measurable outcomes. Subsequently, spreadsheets were used to conduct simple cost-benefit analyses of the adaptation actions. The results of this analysis are expressed in terms of the incremental investments and savings associated with LTS implementation. The influence of uncertainty was also examined by modeling multiple futures within these adaptation analyses.

### 1.4. Synergies between climate change mitigation and adaptation

Several actions in Jamaica's LTS address both mitigation and adaptation objectives. These actions are not only impactful across both climate goals but are also explicitly featured in both the mitigation and adaptation chapters of the LTS. This dual inclusion reflects their strategic importance within the broader Jamaican development and climate agenda. Additionally, a single action can contribute to multiple sectors. This cross-sectoral relevance is particularly evident in adaptation measures, many of which are covered across more than one sector.

In Figure 3, we identify and visualize these synergies. For the purposes of the CBA, and to avoid double counting, each cross-cutting action is attributed to only one sector—the one underlined in the figure. Notably, there is a strong alignment between the Agriculture (mitigation) and Food Security (adaptation) sectors. Therefore, we present the results of these overlapping actions under the Food Security sector. Similarly, there is a high degree of alignment between Forestry (mitigation) and Terrestrial Ecosystems (adaptation), and thus, results are shown under the Terrestrial Ecosystems sector.

The remainder of the document is structured as follows: Section 2 presents the results of the CBA for the mitigation sectors—specifically, electricity, buildings, industry, and transport. The results for the adaptation LTS actions are presented in Section 3, followed by the macroeconomic analysis in Section 4. Section 5 presents the final recommendations.

| LTS actions | Mitigation sectors | Adaptation sectors |
|---|---|---|
| **Forest conservation and reforestation (incl. agroforestry and silvopasture)** | **Forestry:** Forest reforestation and conservation targets | **Terrestrial ecosystems:** forest and biodiversity protection goal<br>**Food security:** impacts on increased productivity in crops |
| **Sustainable and climate-smart agriculture** | **Agriculture:** emission reductions goals, agroforestry and silvopastoral targets | **Food security:** climate-smart agriculture goals and impacts on increased productivity |
| **Sustainable waste management** | **Waste:** prioritization of sustainable waste management | **Population and health:** sanitization access goal and health improvement benefits |
| **Energy storage** | **Electricity:** support to intermittent renewable energy targets | **Critical infrastructure:** Energy system resiliency goals |
| **Low-carbon cooling** | **Buildings:** Energy efficiency potential | **Human settlements:** goals of increasing resiliency to heat waves |
| **Regulation of overfishing** | - | **Coastal areas:** biodiversity safeguards goals<br><br>**Food security:** food security goal |
| **Diversity touristic offering and coastal protections** | - | **Coastal areas:** beach protection goal<br>**Tourism:** resiliency for the tourism industry |

**Figure 3. LTS actions with mitigation and adaptation goals.**

# 2 Costs and benefits of low-carbon measures

This chapter presents the CBA results for the electricity, buildings, industry, transport, and waste sectors of the LTS. OSeMOSYS-based models were developed to compare the costs and benefits of the LTS against a BAU scenario. The table below summarized the modeled costs and benefits.

| Sectors | LTS actions | Costs | Benefits |
|---|---|---|---|
| Electricity | • Increased renewable energy<br>• Limit T&D losses | • Costs of installing power plants and storage<br>• InfrastructureT&D investments | • Reduced reliance on fossil fuels<br>• Reduced fixed operational costs of power plants<br>• Reduced electricity losses |
| Buildings | • Use of solar heating<br>• More efficient lighting<br>• Low-carbon efficient cooking<br>• Low-carbon construction materials | • Costs of devices and low-carbon materials<br>• Investments in energy efficiency programs | • Savings resulting from efficiency<br>• Lower mantainance needs from low-carbon materials |
| Industry | • Reduce clinker-to-cement<br>• Reduce use of coal for cement production<br>• Reduce fuel consumption and sectoral energy intensity | • Costs of reducing clinker-to-cement ratio<br>• Cost of energy efficient infrastructure | • Savings from energy efficiency |
| Transport | • Electrification of vehicle fleet<br>• Reduce truck's fuel consumption<br>• Modal shift | • Cost of EVs and buses<br>• Cost of EV chargers | • Savings from lower fossil fuel use<br>• Lower mantaininace of EVs compared to internal combustion cars<br>• Savings from higher capacity of buses compared to cars<br>• Health benefits |
| Waste | Sustainable waste management | • Infrastructure investment and operational costs | • Health benefits<br>• Valuation of circular economy<br>• Toursim income due to reduce contamination |

**Figure 4. Costs and benefits captured by the analysis for low-carbon measures.**

## A. Electricity and buildings sectors

The CBA in the Electricity and Buildings sectors highlights that the implementation of mitigation actions under the LTS entails a higher total cost of $51.8 billion compared to $50.3 billion under the BAU scenario. However, the breakdown reveals critical insights into how the electricity sector will act as an enabler in decarbonizing other sectors of the economy, by enabling the electrification of cooking, industrial end-uses and transport, as pursued by the LTS.

The largest additional costs in implementing the LTS come from investments in new appliances such as LED lighting, electric ranges, and more efficient refrigerators and air conditioning ($2.0 billion) and using low-carbon materials for construction ($1.8 billion), as shown in Figure 5. Additionally, there are additional investments related to an increased need for power plants ($0.9 billion). While energy efficiency improvements will be achieved, a significant portion of electrification costs will be borne by the electricity sector. Therefore, this sector will play a pivotal role in enabling climate change mitigation in other high-emitting sectors, while ensuring energy security. Although the LTS requires higher electricity generation to support electrification, the fuel costs for electricity generation remain similar between the BAU and LTS scenarios over the next 25 years. This is because fossil fuels continue to play a role during the gradual transition to a fully renewable energy system. Under the LTS, renewables increase from 65% in 2035 to about 90% by 2040, leading to progressively lower fossil fuel use thereafter. The larger fuel cost savings from reduced fossil fuel dependence are therefore expected to materialize beyond 2050, as the power mix becomes entirely renewable by 2050.

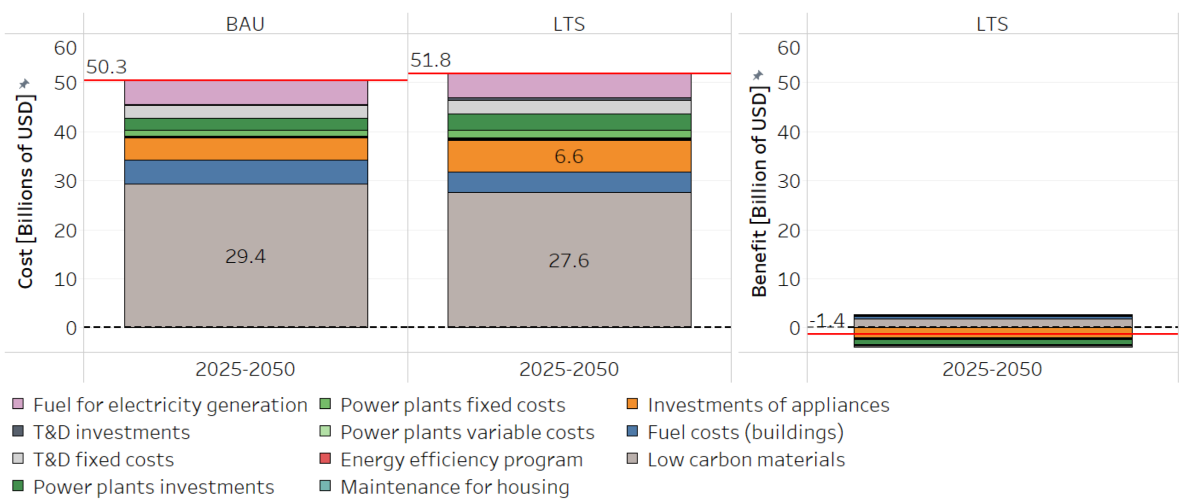



**Figure 5. Aggregated costs and benefits for the electricity and buildings sectors.**

Notably, implementing the LTS will reduce costs associated with the operation of power plants, as these will rely on renewable energy and the system will have fewer T&D losses. As shown in Figure 6, the sector incurs additional costs due to high levels of investment required before 2040 (i.e., primarily power plants and the upgrades needed to reduce T&D losses). However, after 2040, the balance of costs and benefits becomes net positive, driven by reduced investment needs and increased benefits from lower reliance on fossil fuels. Therefore, the benefits of the LTS will be more fully realized in the long term. The sharp cost increase in 2036–2040 reflects the ambitious shift from 65% renewables in 2035 to a full phase-out of fossil fuels in electricity by 2040, alongside electrification of other sectors. This results in high investment and operating costs during that period. However, these upfront efforts enable a cleaner, more efficient energy system. As a result, net benefits begin to emerge from 2041 onward.

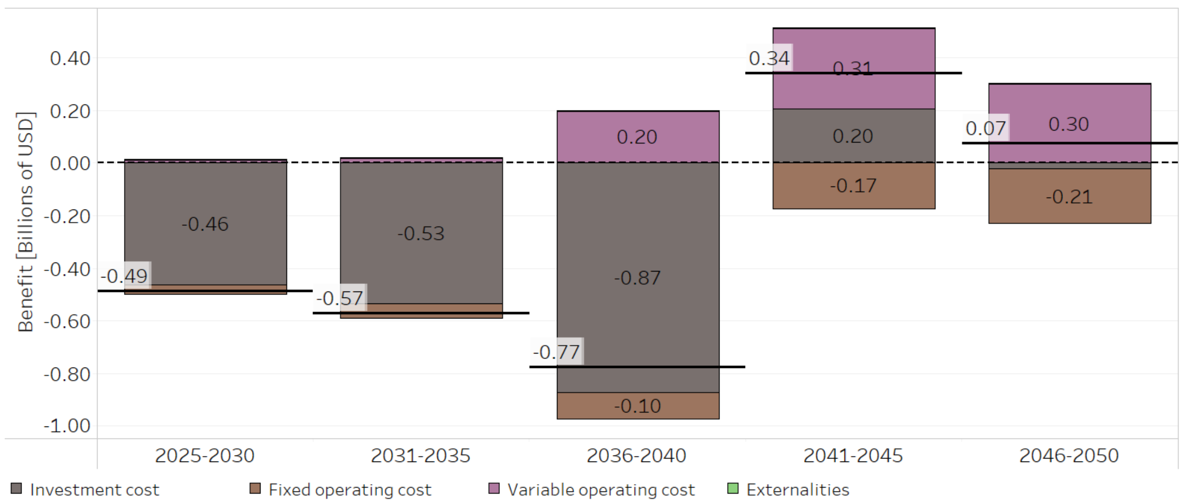



**Figure 6. Net costs and benefits over time for the electricity and buildings sector.**

Beyond what these numbers show, we recognize that there are additional benefits associated with the implementation of the LTS that are difficult to quantify. These include enhanced energy security resulting from a greater reliance on renewable energy and energy storage systems, as well as the potential for improved electricity rates due to the new electricity mix (Sustainable Energy for All, 2020).

### a. Industrial sector

For the LTS mitigation actions related to the industrial sector (i.e., reduced fuel consumption in alumina production, reduced coal use in cement production, and overall energy intensity reduction), there are at least $0.3 billion in benefits (see Figure 7). Most of these benefits originate from fossil fuel savings and, given their scale and the LTS's focus on these industries, around 90% occur in the bauxite mining and alumina processing sectors. While some actions require additional net investments—such as reducing the clinker-to-cement ratio—measures aimed at lowering energy intensity through fuel switching and efficiency improvements generate overall benefits for the sector. As shown in Figure 8, these benefits are gradually realized as the actions are implemented.

Beyond direct financial savings, low-carbon measures in the industrial sector bring additional hard-to-quantify benefits, such as enhanced international competitiveness through alignment to global sustainability goals and access to low-carbon markets (Barbhuiya, S. et al, 2024).

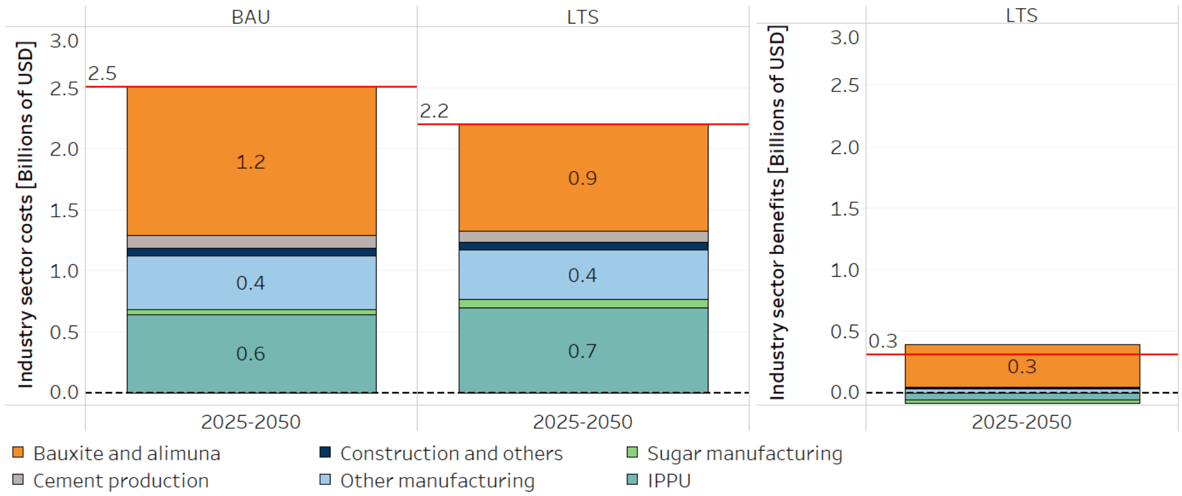



**Figure 7. Aggregated costs and benefits for the industrial sector.**

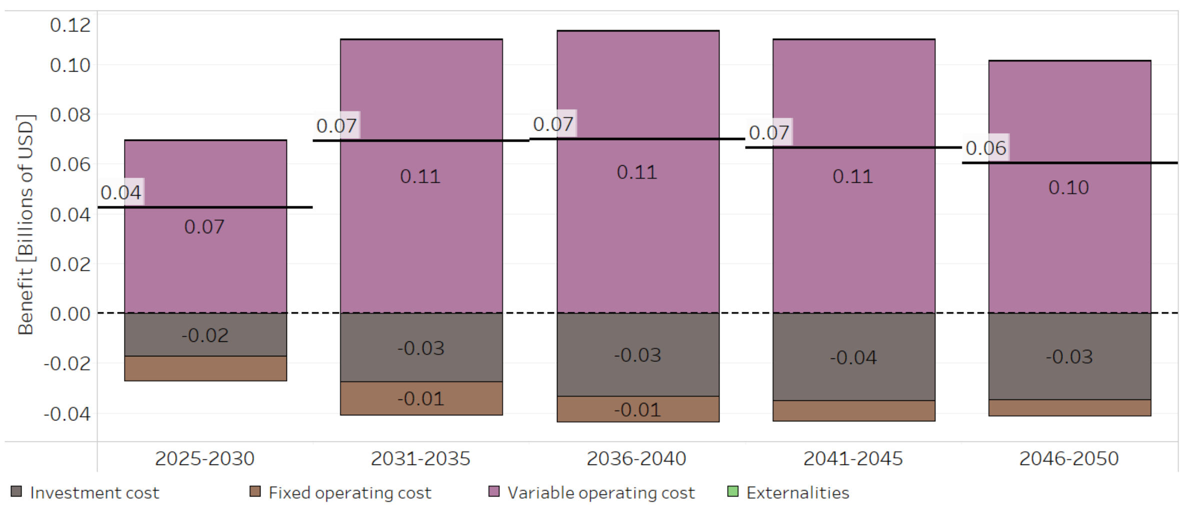



**Figure 8. Net costs and benefits over time for the industrial sector.**

### b. Transport sector

The CBA shows that implementing mitigation actions in the transport sector yields a net benefit of $7.0 billion compared to the BAU scenario. These costs and benefits align with the LTS's ambitious mitigation goals for the sector. Significant additional capital investments are required to electrify the vehicle fleet and install electric chargers, amounting to $7.7 billion. However, long-term benefits are realized through cost savings from reduced gasoline demand, estimated at $4.3 billion, and reduced investments in internal combustion vehicles (ICV; $7.2 billion). Additionally, the LTS delivers health and environmental benefits by reducing reliance on fossil fuels. Health-related negative externalities are directly linked to fossil fuel consumption; therefore, they are higher under the BAU scenario. By contrast, the

LTS is expected to lower healthcare system costs. However, these externalities are not entirely eliminated in the LTS scenario, as fossil fuels are still used in freight transport and a portion of the vehicle fleet remains non-electrified (the LTS targets 67% electrification in private passenger transportation). The mean $PM_{2.5}$ level in Jamaica is estimated to be three times higher than the WHO guideline[4].Reducing air pollution presents a vital opportunity to protect public health today and ensure a healthier, more sustainable quality of life for future generations. (WHO, 2022). Another key insight is that the modal shift proposed by the LTS will reduce the need for investments in the overall number of vehicles, due to greater reliance on public transportation and non-motorized modes of travel. This modification contributes to the $4.3 billion mentioned above.

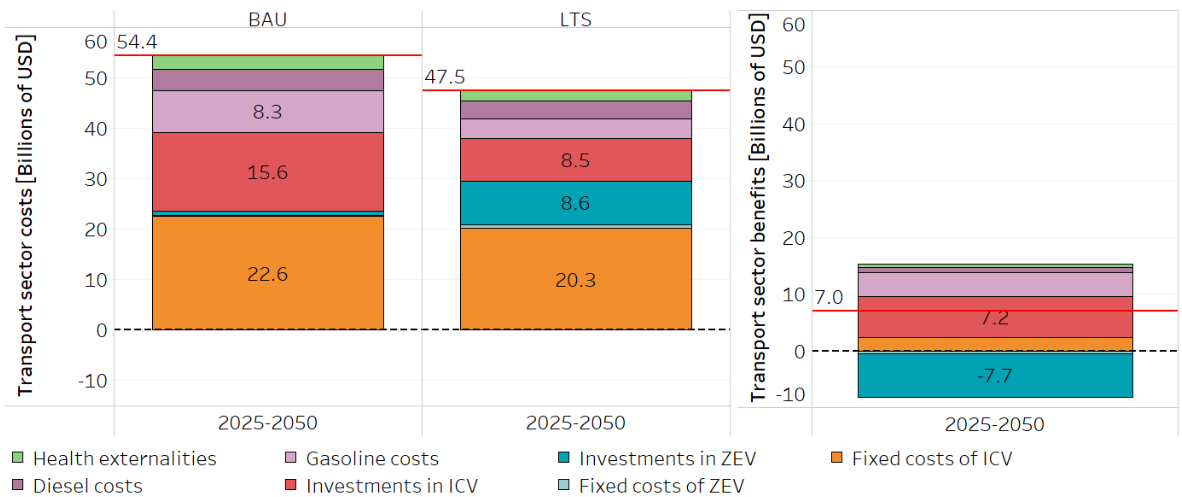



**Figure 9. Aggregated costs and benefits for the transport sector.**

Given the way the LTS sets short-, medium-, and long-term milestones for the sector, the net benefits are realized throughout the entire period (see Figure 10). Beyond the 2025 and 2030 vehicle electrification milestones in the LTS, the cost-benefit analysis assumes an S-curve adoption pattern for Electric vehicles. This leads to higher investment needs after 2040 as electrification accelerates, reflected in the increased capital outlays of the LTS scenario. However, the lower operational costs of electric vehicles and sustained health benefits help maintain strong net benefits over time.

[4] PM2.5 refers to very small air pollution particles that are small enough to be breathed deep into the lungs. Vehicle emissions mainly increase $PM_{2.5}$ levels through fumes released from the vehicle's tailpipe and chemical reactions in the air. On the other hand, $PM_{10}$ is more often linked to larger particles such as road dust.

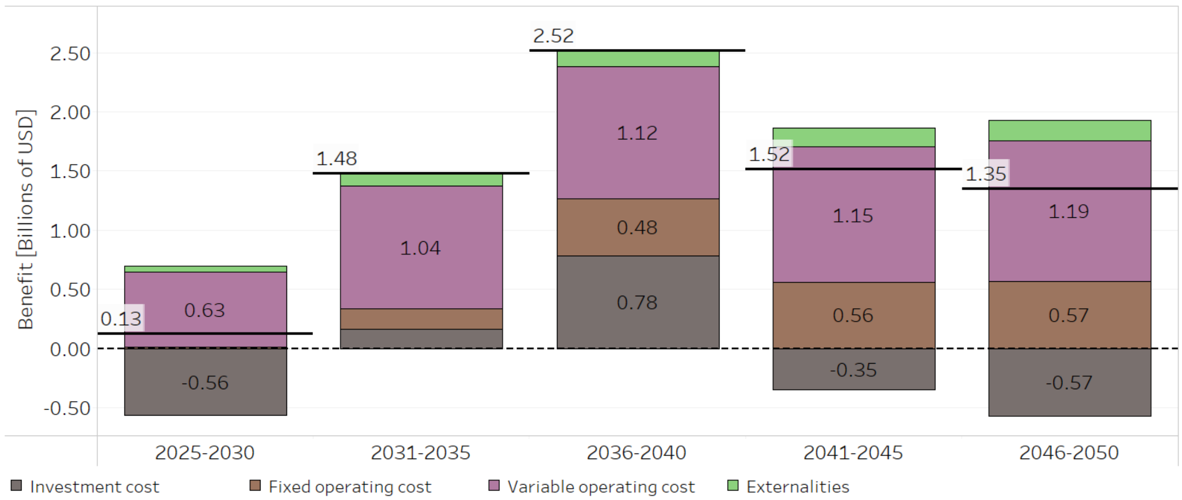



**Figure 10. Aggregated costs and benefits for the transport sector.**

It is important to recognize that electrifying the vehicle fleet and shifting toward public and non-motorized transport bring additional, hard-to-quantify, additional co-benefits that were not quantified in this study. These include increased productivity from reduced traffic congestion, fewer road accidents and related fatalities, and improved public health due to increased physical activity. Such changes can also contribute to greater urban liveability and energy security. In this case, these benefits were not included in the analysis due to data limitations. The IMF 2023 Fossil Fuel Subsidies Data estimates that externalities from congestion and accidents on gasoline use bring an external cost that ranges from about USD 0.30 to 1.10 per liter in selected countries, reflecting substantial social costs beyond existing fuel prices (Black et al, 2023).

### c. Waste sector

When we look at the waste sector, sustainable waste management could bring $0.6 billion in benefits compared to the BAU scenario. There are additional investments and variable costs associated with this goal ($0.3 billion), linked to the construction and operation of new infrastructure. However, these costs are outweighed by the benefits that arise from improved waste management and water use. These health benefits include savings of $0.4 billion in the case of waste-related diseases, $0.2 billion from avoiding water contamination, and $0.3 billion from the benefits of a circular economy. Given the assumptions of this analysis, the benefits could be perceived throughout the entire period (see Figure 12). While the country continues to define its pathway for sustainable waste management, this scenario considers the implementation of organic waste recycling and wastewater reuse, as described in the Annex a.

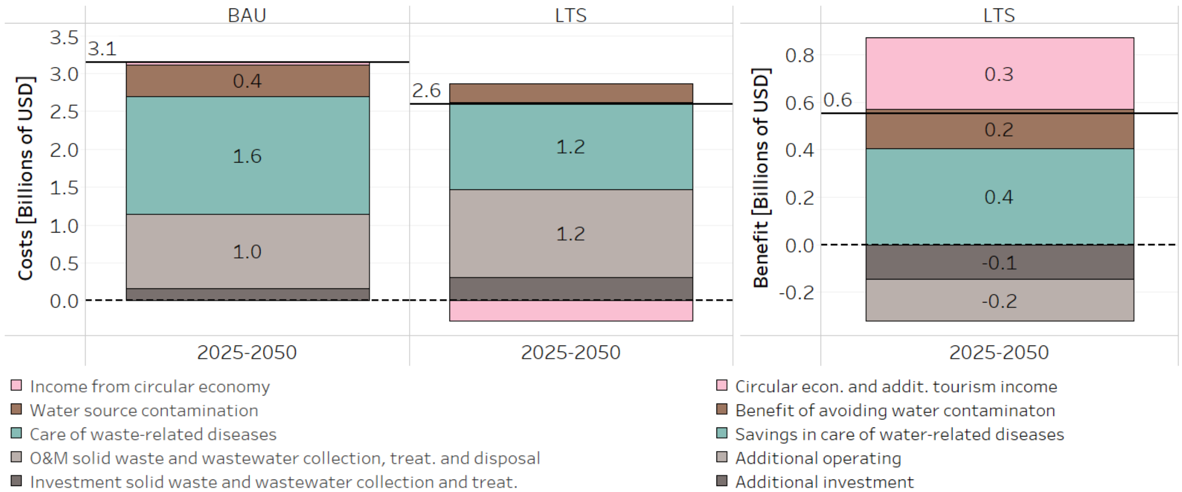



**Figure 11. Aggregated costs and benefits for the waste sector.**

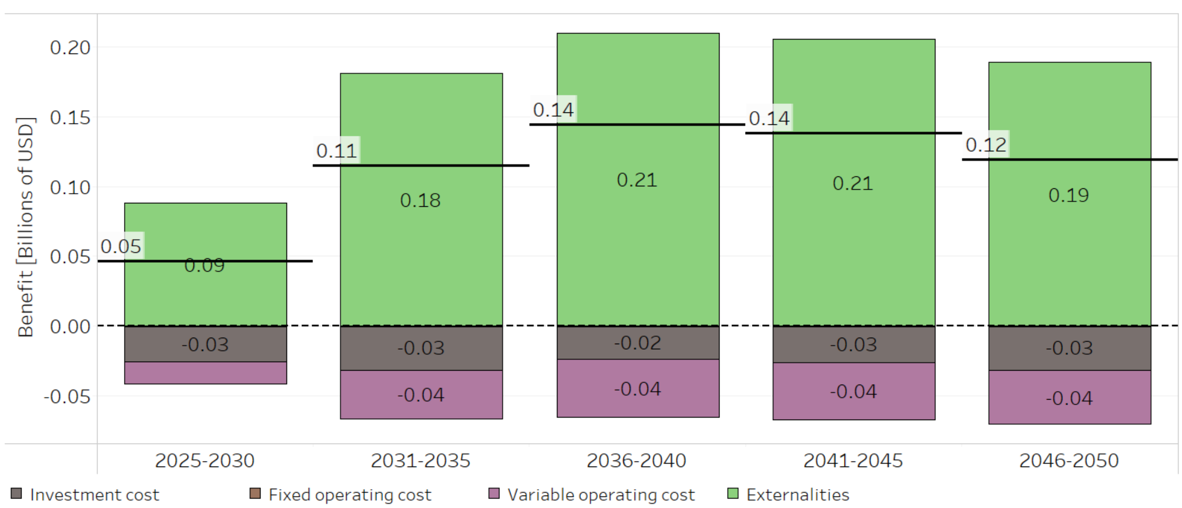



**Figure 12. Aggregated costs and benefits for the waste sector.**

# 3 Costs and benefits of adaptation measures

This section presents the adaptation results. It includes a set of strategies that are planned or implemented in the country, and which support the qualitative LTS adaptation goals. The identification of these strategies is one of the outputs of this analysis, and the final list is validated by key stakeholders.

The costs and benefits for the sectors are presented at the beginning of each section. While not exhaustive, the analysis concludes that the LTS actions are cost beneficial.

The evaluated scenario reflects the incremental costs and benefits associated with implementing the LTS actions, compared to a scenario without them. This CBA was calculated using spreadsheets, and the values used are presented in Annex a. Whenever possible, the analysis incorporates estimates of losses and damages avoided through the implementation of LTS actions.

### A. Food security sector

The LTS envisions Jamaica adopting Climate-Smart Agriculture (CSA), improving irrigation efficiency, adjusting crop patterns to seasonal changes, and promoting climate-resilient crops. These measures aim to boost productivity, conserve resources, and protect livelihoods, fostering a more resilient agricultural sector and sustainable economic growth. Figure 13 outlines the LTS actions and corresponding specific actions that were identified for the Food Security sector, along with the associated costs and benefits. It is worth noting that a single "LTS action" (i.e., general actions explicitly mentioned in the LTS) can have more than one "specific action" (i.e., strategies and initiatives that are more specific but still aligned with the LTS action; as illustrated in Fig. 13) associated with it. For instance, the LTS explicitly mentions the goal of implementing climate-smart agriculture. While more specific strategies may not be explicitly stated in the LTS, strategies such as implementing crop rotation or using drones in agriculture are aligned with this general LTS action.

The results in Figure 14 show that the benefits of the Food Security sector actions outweigh their costs, with a net benefit of $0.35 billion over the 2025–2050 period. These benefits stem primarily from the implementation of climate resilient crops and climate smart agriculture strategies outlined in Figure 13. The expected increase in crop productivity from sustainable practices will be essential to meeting the LTS reforestation targets. By producing more food on less land, these practices help reduce pressure on forested areas, enabling their protection and expansion.

In addition to the benefits that are included in this analysis, non-monetized benefits include improved food security and nutrition resulting from the identified strategies, as well as environmental gains from adopting sustainable agricultural practices such as reduced soil erosion and improved nutrient management (FAO, 2023).

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Develop and implement **Climate-smart agricultural** frameworks that integrate climate change risk with food and nutrition security. | Expansion of **agroforestry systems**<br><br>Implementation of **terraces**<br><br>Implementation of **crop rotation** and **intercropping**<br><br>**Drones** acquisition<br><br>Installation of **cold storage facilities**<br><br>**Trainings** in drone use and climate-smart agriculture | **Equipment purchase and setup**<br><br>**Trainings**<br><br>**Inputs, maintenance, transportation, monitoring**<br><br>**Technical assistance** | **Soil loss avoided** by implementing terraces and agroforestry<br><br>**Biodiversity**<br><br>**Increases in production yields**<br><br>**Reduction** in the use of **pesticides** |
| Enable **innovative irrigation** methods to adapt to drought conditions and capacity building in farming communities. | **Rainwater harvesting systems**<br><br>Implementation of **drip and subsurface irrigation**<br><br>**Trainings** in irrigation use | **Infrastructure** and **labor, and materials**<br><br>**Trainings**<br><br>**Maintenance, monitoring** | **Benefit of water availability** during dry periods<br><br>Increased irrigation **efficiency**<br><br>**Water savings**<br><br>**Enhance crop yields** |
| **Adapt agricultural practices** to new growing patterns and seasonality and promote vulnerable crops substitution with climate-resilient alternatives | Implementation of **varieties tolerant to pests, diseases, heat, water stress** and **flooding**<br><br>**Wind tolerant** varieties of **banana**<br><br>**Insect** production systems **(farms)**<br><br>Adoption of **Hydroponic fodder** production for **livestock**<br><br>**Cassava** root meal as **substitute for maize in animal feed**<br><br>Provision of **sweet potato** planting material and technical **trainings** on crop management | **Infrastructure** and **equipment**<br><br>**Training programs**<br><br>**Inputs** and **materials**<br><br>**Technical support, monitoring,** and ongoing **maintenance** | **Reduced crop losses**<br><br>**Financial benefit of alternative protein** from insects<br><br>**Space-saving** food production<br><br>**Increased yields**<br><br>Improved livestock production **efficiency**<br><br>**Lowers dependence on external inputs** like maize<br><br>Boosts **food security** with sweet potato |

**Figure 13. Specific actions, costs and benefits corresponding to the food security sector.**

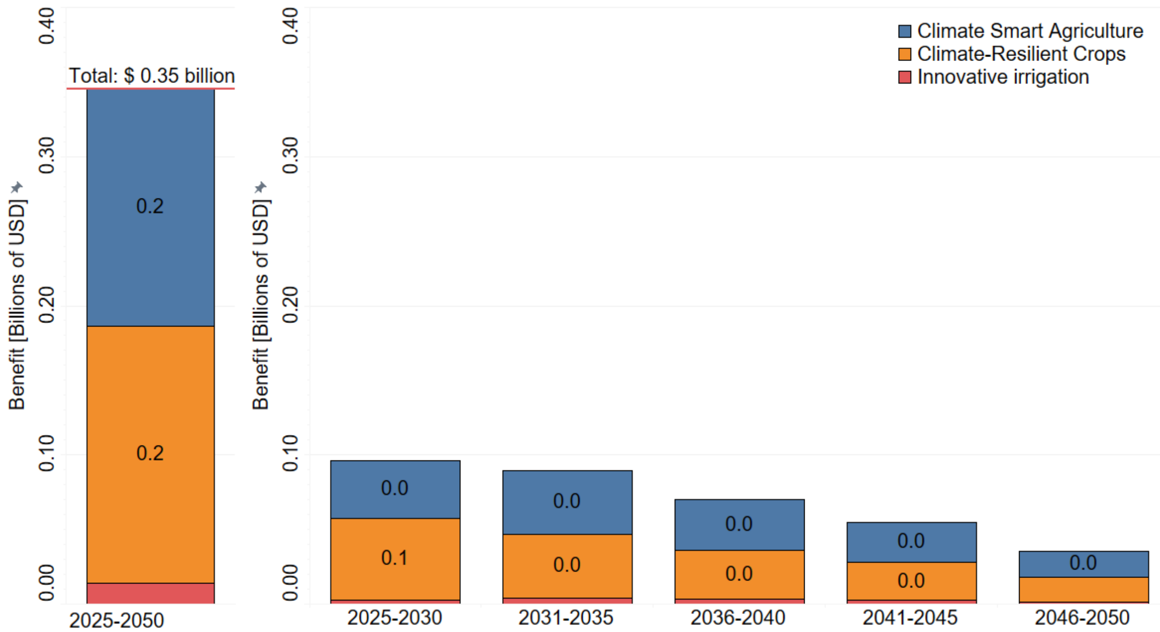



**Figure 14. Costs and benefits associated with the food security sector.**

## a. Terrestrial Ecosystem sector

The LTS chapter corresponding to Terrestrial Ecosystems prioritizes forest preservation and restoration to address climate change, protect biodiversity, and sustain ecosystem services. These efforts aim to boost resilience, attract conservation funding, and foster participatory governance for forest conservation and restoration. For this CBA, the sector's LTS actions were linked to specific strategic measures, costs and benefits outlined in Figure 15 below.

The results indicate that the benefits of the actions in the Ecosystems sector exceed the costs. The net benefit amounts to $0.07 million, with the actions implemented between 2025 and 2050 at varying frequencies and durations. Costs and benefits are calculated based on the number of hectares expected to be reforested under the LTS mitigation actions, relative to current levels. The primary benefits in this sector come from ecosystem services, particularly air purification and pollination. Notably, costs are expected to be incurred upfront, as ecosystem services are realized only several years after restoration and conservation efforts are implemented.

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Prioritize **forest governance** and biodiversity conservation | Develop and Lead Forest **Invasive Species Control Plans**<br><br>Develop (pilot) **species conservation plans and Species Mapping**<br><br>Expand and accelerate the **boundary verification program**<br><br>Mechanism to integrate the **Forest Sector** into **national decisions.**<br><br>Development of **regulations** that permit and license **activities** | Government **procedures** and institutional **processes**<br><br>**Costs outlined in the National Forest Management and Conservation Plan** | **Protection** of ecosystems and **species**<br><br>**Reduction** of conflicts and deforestation<br><br>Strengthens **enforcement capacity** |
| **Expand sustainable forest management** and increase forest coverage by protecting and restoring ecosystems | **Increase** forest and mangrove **cover**<br><br>Implement **forest conservation**<br><br>Improve and develop **Forest Management and Protection Plans**<br><br>Implement and expand the **plant nursery program**<br><br>Implementation of **silviculture trainings**<br><br>Establishment of **Permanent Sample Plots (PSP)**<br><br>Establishment of **Agroforestry Demo plots**<br><br>Installation of a **tissue culture lab**<br><br>**Native trees planting initiative** | **Infrastructure** and **equipment**<br><br>**Materials** and **inputs**<br><br>**Labor** and **personnel**<br><br>**Trainings** and **capacity building**<br><br>**Administrative** and **miscellaneous costs** | **Revenue** generated by the **nursery program**<br><br>**Soil erosion reduction**<br><br>Lowering **livestock heat losses** through **silvopastures.**<br><br>Value of **tourism** and **recreation**<br><br>**Value of biodiversity conservation**<br><br>**Air purification**<br><br>**Pollination**<br><br>**Medicinal plants** obtained from forests<br><br>**Water supply** and **water purification** from forests |

**Figure 15. Specific actions, costs and benefits corresponding to the terrestrial ecosystems sector.**

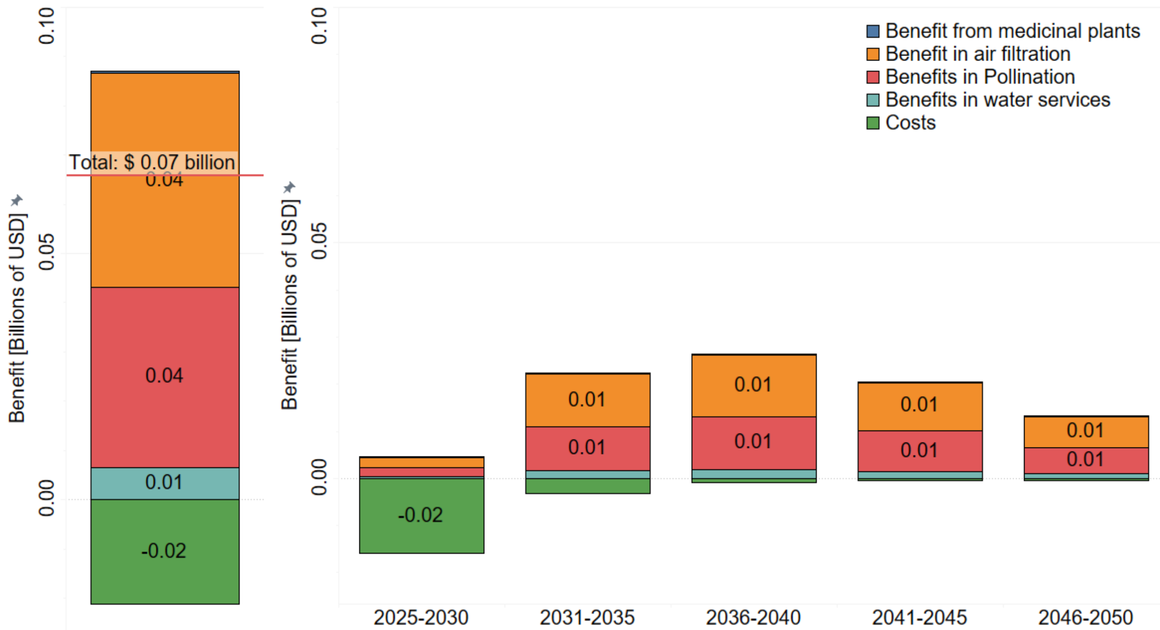



**Figure 16. Costs and benefits associated with the terrestrial ecosystems sector.**

### b. Human settlements

The Human Settlements sector aims to reduce housing vulnerabilities and safeguard inland assets by planning for coastal retreat and constructing coastal defences. Additionally, the government will promote microinsurance products to accelerate disaster recovery. These measures enhance community resilience, protect critical infrastructure, and support faster post-disaster recovery.

The results show a net cost for this sector, amounting to $2.71 billion in Figure 18, which will require special attention. Specifically, there are major costs associated with the installation of housing units. On the other hand, this sector presents a mix of quantified and unquantified benefits in this analysis. The list of quantified benefits, especially associated with addressing informal settlements with housing solutions, include reduction in gastroenteritis incidence, increased income and decreased mortality attributed to household air pollution. In Jamaica, there are approximately 750 informal settlements with roughly 600,000 people living in them, according to the last population census (Jamaica Information Service, 2024). Furthermore, many additional benefits remain unquantified due to challenges in valuation, such as reductions in domestic injuries, improvements in mental health due to resilient human settlements, reduced losses and damages from implementing coastal protection infrastructure, health benefits due to access to cooling solutions, decreased exposure to environmental hazards, and increased school enrollment. These aggregated benefits have the potential to impact on the cost-benefit ratio. In fact, existing research suggests that equitable access to adequate housing in informal settlements can generate a direct economic growth impact of up to 10.5% at a country level (Frediani, A.A. et al, 2023). In addition, there are benefits that come with having a microinsurance products available, such as a faster recovery.

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Reduce **vulnerability of populations living in informal settlements** by the develop of **housing programs** | **Housing unit construction** | **Materials**<br>**Construction** and **design**<br>**Permits**<br>**Utility** connections | **Health** improvement<br>Increase in **income** |
| Increase roll-out of **low carbon cooling initiatives** in both urban and rural settlements, prioritizing informal settlements | **Reflective roof coatings** | **Installation costs**<br>**Materials**<br>**Maintenance** | |
| Development of **microinsurance products for post-disaster recovery** | **Microfinance** institutions receiving technical assistance to develop **microinsurance products** | **Product development**<br>**Marketing** | |
| **Build sea walls** and other defenses **to protect key coastal assets** | Construction of **grey infrastructure** protection measures | **Materials**<br>**Design**<br>**Construction**<br>**Maintenance**<br>**Permits** | |

**Figure 17. Specific actions, costs and benefits corresponding to human settlement sector.**

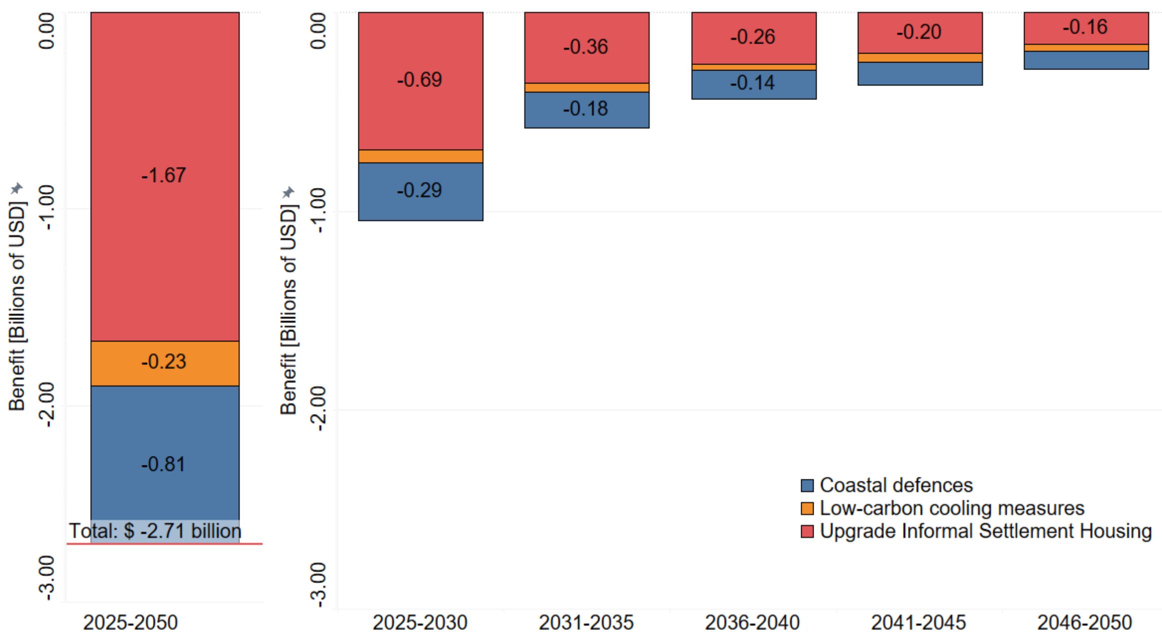



**Figure 18. Costs and benefits associated with the human settlement sector.**

## B. Critical Infrastructure

The Critical Infrastructure sector aims to enhance the resilience of water, energy, and transport systems to withstand climate impacts. In parallel, it emphasizes strengthening institutional processes to better serve the population. Key measures include expanding water storage to reduce shortages, applying Nature-based Solutions (NbS) for flood management, and diversifying the energy sector. Figure 19 summarizes the specific actions that were identified as aligned to the LTS goals.

The results show that there are a total of $9.12 billion in benefits resulting from implementing strategies aligned with the LTS goals. In particular, this study has found that implementing a national non-revenue water project in the country could yield significant benefits, stemming from reduced needs for water production, reduced damage to infrastructure, among others.

It is important to note that, in addition to the considerable quantified benefit, these actions generate significant hard-to-quantify benefits as well. Examples include the potential for biomass production for energy generation in constructed wetlands and the avoided costs of vehicle repairs due to improved road conditions.

| LTS actions | Specific actions | Costs | Benefits |
|---|---|---|---|
| Conduct **vulnerability and risk assessments** | **Community-level CCVA** | **Specialized expertise** in infrastructure systems and climate modeling<br>**Technical resources**<br>**Data collection** and **analysis** | **Identification** of critical infrastructure **vulnerabilities**<br>Enhancement of **preparedness** and **resilience**<br>**Prioritization** in infrastructure **investment** and **planning** |
| Adapt by integrating **Nature-based Solutions (NbS)** | Construction of **artificial wetlands** for secondary/ tertiary **wastewater treatment** | **Land acquisition** and **site preparation**<br>**Design** and **engineering** for hydrological function<br>Long-term **maintenance**<br>**Construction** | **Climate resilience**<br>**Aesthetic** value<br>**Public health** through enhanced **water quality** |
| Adapt **water infrastructure** to climate variability | Retrofitting and maintenance of **pipelines** and **wastewater** systems<br>Installation of **rainwater harvesting** systems<br>**Reduction** of **non-revenue water** | **Infrastructure upgrades**<br>**Construction** and **maintenance**<br>**Inspection and leak detection**<br>**Trainings** | **Reduced damage** probabilities<br>**Savings** in the production of potable water<br>Increased **access** to water and greater **availability** |
| Enhance the **resilience of transportation** infrastructure, including roads, bridges, and ports, through coordinated design and land use practices | **Retrofitting** of roads<br>Road **rehabilitation** | **Materials, machinery** and **labor**<br>**Planning, engineering** and **site assessments**<br>**Maintenance** | Transport **efficiency**<br>**Reduction** of vehicle **operating** and **maintenance costs**<br>**Climate resilience** |

**Figure 19. Specific actions, costs and benefits corresponding to critical infrastructure sector.**

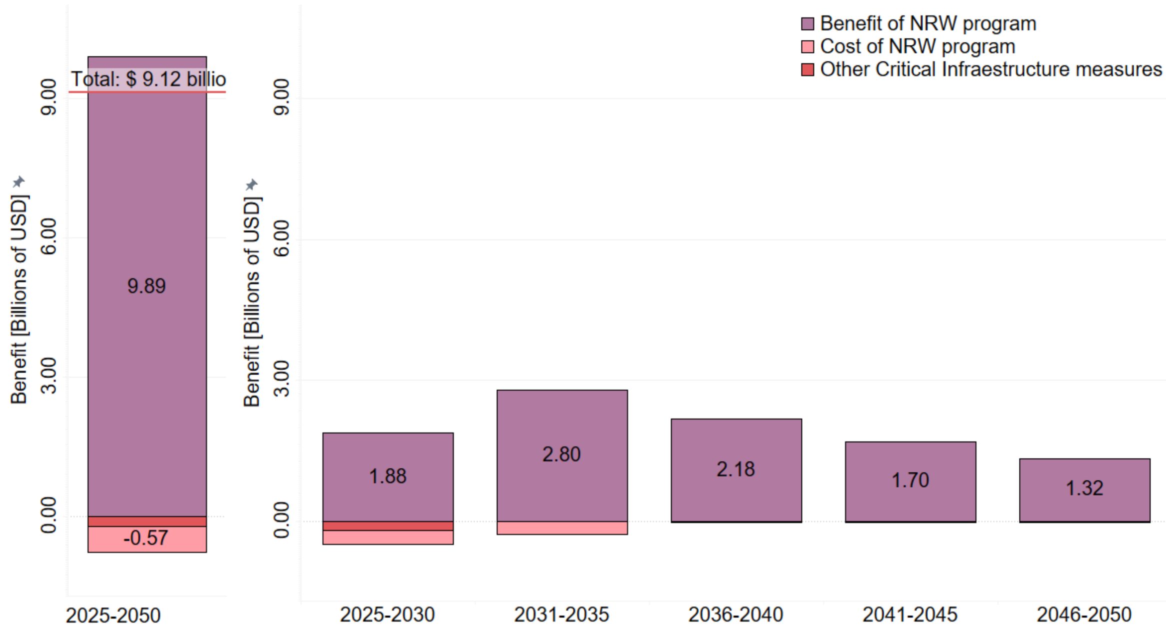



**Figure 20. Costs and benefits associated with the critical infrastructure sector.**

### c. Tourism sector

The results corresponding to the Tourism Sector show that the benefits of the adaptation actions for the Tourism sector are greater than the costs, highlighting an advantageous return on investment ($0.1 billion). Most benefits come from strengthening the Protected Areas Framework (PAF). Additionally, the diversification of tourism offerings is an innovative approach to reduce pressure on coastal ecosystems. Investments in rural, community, and eco-tourism initiatives—such as upgrading heritage sites at $23 million per site—expand Jamaica's market appeal and distribute visitor impact across regions. Such diversification also fosters inclusive economic growth by involving local communities in tourism development, which is a benefit that goes beyond what was quantified in this analysis.

In addition to the actions that were studied here, the LTS also has the goal of investing in Nature-based Solutions (NbS) for coastal rehabilitation, beach nourishment, and artificial reef projects, in addition to introducing best practice standards and regulations for land management to reduce runoff of polluting sediment and fertilizers. These actions were not included in the CBA due to a limitation in data. However, practices such as artificial reef projects are innovative, engineered solutions associated with benefits such as reduced coastal erosion, provision of marine habitats, and support for recreation and tourism with activities such as snorkeling and diving. There are international examples of these interventions being coupled with other interventions, such as beach nourishment, to reduce coastal erosion (Salyer, A. 2024).

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| **Diversify the touristic offering**: cultural heritage and diverse natural environment. | **Expand experiences** to include rural and community tourism, nature and eco-tourism, adventure tourism and heritage tourism<br>Develop a **Tourism Strategy and Action Plan** | **Marketing**<br>**Storyboards** and directional **signs**<br>**Development** and **management** | **Income Diversification**<br>Cultural and Natural **Resource Preservation** |
| Regulate, monitor and enforce a **reduction in overfishing** and illegal fishing practices. | Define **fish sanctuaries**.<br>Extend **training of staff**.<br>Add additional staff for **monitoring**. | **Sanctuaries protection**<br>**Consultation processes**<br>**Trainings and monitoring** | **Conservation**<br>**Fish Stock Recovery**<br>**Community Involvement** |
| Invest in **hard and soft engineering solutions to protect beaches**. | Provide **seaside parking**<br>Implement **setbacks**.<br>Beach **vegetation** planting<br>**Coral reef, mangrove** and **seagrass restoration** | **Materials, transport, labor and underwater work**<br>**Monitoring and maintenance**<br>**Trainings and hiring specialized personnel**<br>**Technical studies**<br>**Environmental assessments** | **Increased income**<br>**Protection from storm damages**<br>**Biodiversity**<br>**Increase in carbon sequestration**<br>**Improved water quality**<br>**Boosts local tourism and recreational value**<br>**Natural wave barriers** |
| Strengthen and promote **protected areas** through a comprehensive **policy framework** | Integrate **climate adaptation** into **protected area** planning<br>Implement **National Mangrove** and **Swamp Forest** Plan<br>Strengthen **stakeholder engagement** and **marketing strategies** | **Trainings, monitoring**<br>**Planning studies**<br>**PA designs**<br>**Marketing, campaigns**<br>**Database** updates | Increased **income**<br>**Protection** of **coasts** and **biodiversity**<br>Boosts **eco-tourism** and **public awareness** |

**Figure 21. Specific actions, costs and benefits corresponding to tourism sector.**

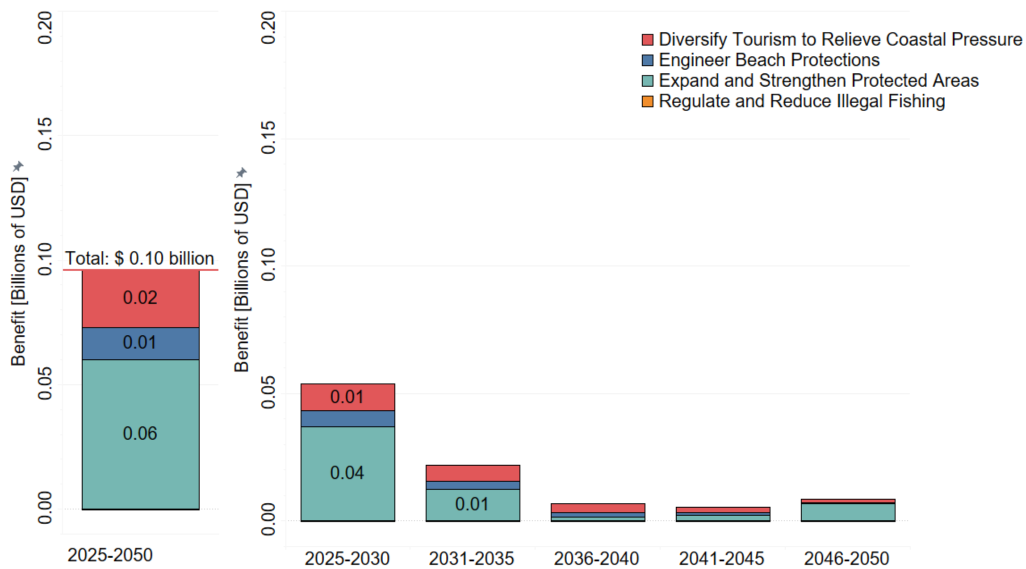



**Figure 22. Costs and benefits associated with the tourism sector.**

### d. Coastal Areas

This Coastal Areas sector of the LTS affirms Jamaica's commitment to protecting coastlines, restoring ecosystems, and strengthening coastal community resilience. Jamaica is a leading tourism destination in the Caribbean, where coastal assets underpin the tourism sector and play a central role in economic activity. Just in 2024, Jamaica welcomed more than one million cruise passengers representing more than US$200 million to the local economy (JIS, 2024). Beyond tourism, coastal areas also host a large share of businesses and critical infrastructure such as seaports, airports, and major urban centres. These areas are critical for employment and food security. In 2019, the fisheries sector contributed directly and indirectly to the livelihood of approximately 100 000 people (Caribbean Natural Resources Institute, 2020). Key efforts that are part of the LTS include shoreline protection and Nature-based Solutions (NbS) like mangrove restoration and artificial reefs. The table below outlines the corresponding specific actions that were identified for each LTS action.

The results highlight net costs in the Coastal Areas sector ($0.58 billion), particularly due to the expansion of mangrove areas, as targeted in the LTS. However, the analysis also identifies notable benefits from reef restoration, which delivers important ecosystem services. Both mangrove and reef restoration efforts contribute valuable, though often unmonetized, ecosystem services. Therefore, it is important to clarify that this study does not fully capture the value of these practices.

To improve decision-making, it will be essential to assess the cost-benefit ratios of specific initiatives and restoration sites, recognizing that each location has a unique restoration potential. Consequently, the costs and benefits of restoration will vary depending on the ecological conditions, land use, and local socio-economic context. Evidence shows that cost-benefit ratios can differ significantly across sites (The Nature Conservancy, 2020), underscoring the importance of tailoring interventions to the characteristics of each area. Additionally, the LTS outlines further actions not included in this analysis, such as reducing coastal erosion through bioengineering solutions and participating in payment-for-ecosystem services schemes. These actions were not quantified due to limited clarity on the specific solutions to be implemented and on the approach for designing the payment mechanism. However, it is important to note that a payment-for-ecosystem-services scheme could serve as an enabling mechanism to achieve other LTS targets, such as advancing forest growth and preserving ecosystem services. Several key ecosystem services are quantified, as described in the section on the terrestrial ecosystems sector.

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Expand **reef restoration** practices | **Reattachment** of **detached coral**<br>**Coral reef crisis campaign**<br>**Monitor reef fisheries**<br>Prevent and respond to **oil** and **chemical spills** | **Diving operations**<br>**Campaigns, materials**<br>**Equipment** and **staff** for **fisheries surveillance**<br>**Spill response kits, trainings** | **Reduction of reef damage**<br>**Ecosystem services**<br>**Support of sustainable fisheries**<br>**Boosts tourism** |
| Expand **mangrove conservation** and restore at least 1,000 hectares of mangroves and swamps. | Conduct **research**<br>**Restoration, removal of loose fouling materials, afforestation, relocation**<br>**Monitor** and **enforce framework** for wetlands<br>Establish **boundaries and zoning** | **Technical studies**<br>**Field labor** and **materials**<br>**Inspections**<br>**Mapping and signage** for boundaries<br>**Community engagement** | **Ecosystem services**<br>**Prevention of conflicts** through clear zoning and boundaries<br>**Strengthens legal protection** and long-term **conservation** |
| Develop and implement **early warning systems (EWS)** and risk preparedness measures to improve **response to hurricanes** and other **coastal hazards** | Increase the number of **monitoring stations**<br>Mechanisms for **real time data** and transferring information to key stakeholders.<br>Update the **resilience / bleaching monitoring** and **response plan** | **Installation** and **maintenance**<br>**Technology** and **software**<br>**Staffing** and **training**<br>Updating of **response plans**, including stakeholder **consultations** | Hurricanes and floods **loses prevention** |

**Figure 23. Specific actions, costs and benefits corresponding to coastal areas sector.**

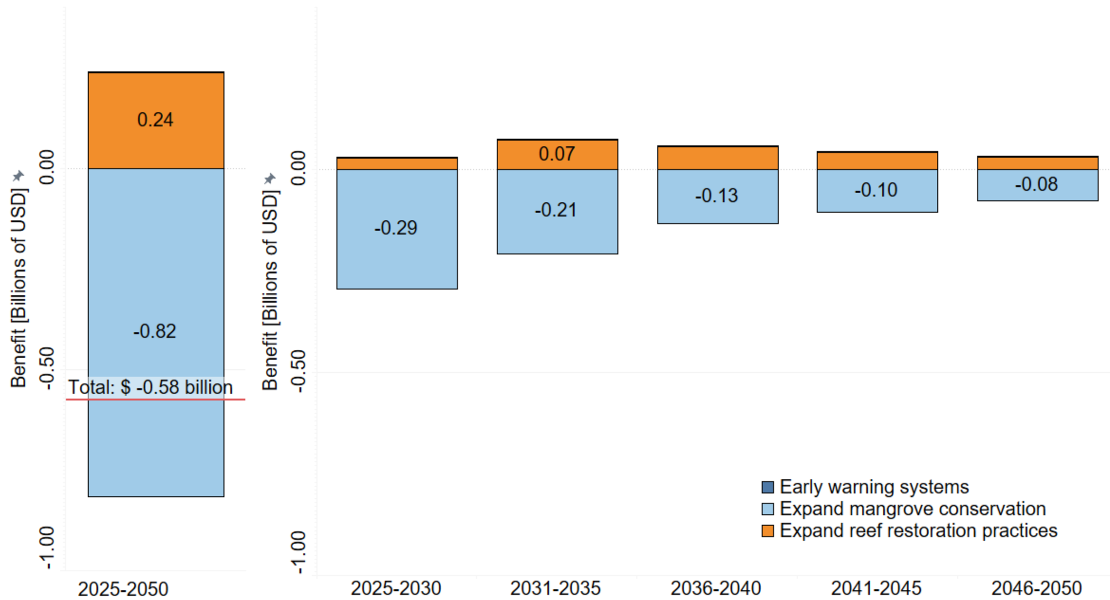



**Figure 24. Costs and benefits associated with the coastal areas sector.**

### e. Culture and Heritage

Regarding the Culture and Heritage sector, in the analysis, we included specific actions that we identified and could quantify their costs. However, this is a sector with intangible benefits. In a bilateral meeting with the Ministry of Culture, Gender, Entertainment and Sport, we identified other specific strategies that were not included here because of a lack of data. For instance, in order to preserve documentation of traditional knowledge and practices, the Ministry undertakes tasks such as recordings, incorporating this type of information in radio programming, digitalization of existing resources, leading workshops, and thinking of innovative ways to create museums, among others. The LTS also sets the target of preserving and increasing knowledge of Jamaican history. The Ministry undertakes workshops with other institutions to spread culture throughout all planning processes, and creates ads, festivals, contests for artists, among others. These actions generate important unmonetizable benefits, such as the preservation of cultural identity, intergenerational transmission of traditional knowledge, and strengthened social cohesion. They also contribute to community resilience, and a deeper connection to heritage. These are outcomes that are vital for societal well-being but difficult to express in monetary terms.

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Create a climate-resilient national **inventory facility** for **cultural heritage sites** and **artefacts** and develop **risk management plans**, as well as **mitigation** and **adaptive** measures for these sites. | Increase **flood resilience** by **elevating structures** and **equipment**<br><br>Increase **hurricane and winds resilience** by installing **impact-resistant windows, doors, roof clips** and **ties**<br><br>Increase **drought and heat resilience** by using **prodex 10mm insulation** and **radiant barrier**<br><br>Install **double glazed windows.** | **Structural modifications**<br><br>**Procurement** and **installation**<br><br>**Materials** and **labor**<br><br>**Maintenance** and **monitoring systems** | **Protection** of artefacts<br><br>Reduction in **storm-related structural damage**<br><br>Improved climate control for **artefact preservation**<br><br>Energy efficiency and **lower cooling costs**<br><br>**Extended lifespan** of cultural materials<br><br>Increased facility **resilience** |
| Increase collaboration with **traditional and indigenous communities** to improve and preserve **documentation** of **knowledge** and **practices** | Develop a **database** for intangible culture | **Human Resource Costs** like developers, project managers, testers, and support staff<br><br>**Bidding Process, Security**<br><br>**Integration** and **maintenance**<br><br>**Legal** and **administrative** | Intangible heritage **preserved, organized** and **accessible** to the public, boosting **appreciation** and **participation**<br><br>Promotes **ownership, recognition,** and **visibility** of community knowledge and practices. |

**Figure 25. Specific actions, costs and benefits corresponding to the culture and heritage sector.**

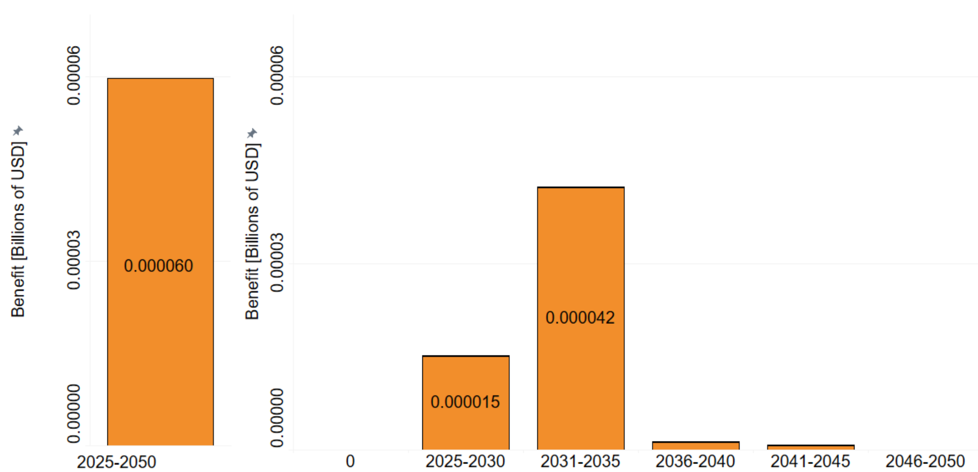



**Figure 26. Costs and benefits associated with the culture and heritage sector.**

### f. Population and Health

The results indicate that the benefits of the adaptation actions for the Population and Health sector far exceed the costs, demonstrating a high rate of return. The difference between the benefits and costs amounts to US$1.1 billion, with the adaptation actions being implemented over the period from 2025 to 2050, at varying frequencies and durations. Here, the sector will experience net costs during the first years associated with the necessary infrastructure investments. However, the benefits are expected to be perceived and outweigh costs in the years afterwards. Even when the investments continue, the sector shows net benefits. The main quantified benefits are coming from improving the water quality and access in the country, amounting to US$0.9 billion. This amount reflects the costs avoided of treating water-borne diseases for the part of Jamaican population that have limited or no access to basic hygiene services. This is achieved through the implementation of actions as the Water Supply Development Strategy for Non-Utility Service Areas.

| LTS actions | Specific actions* | Costs | Benefits |
|---|---|---|---|
| Develop a monitoring and planning program to improve **water quality and sanitation supply** | **Water Supply Development Strategy** for Non-Utility Service Areas<br><br>MAR **(Managed aquifer recharge)** scheme<br><br>Implementation of **Aquifer Protection zones** (APZ)<br><br>**Aquifer monitoring** | **Infrastructure** and **installation**<br><br>**Hydrogeological studies** and **mapping**<br><br>Legal and regulatory **framework setup**<br><br>**Technical staff**<br><br>**Zoning enforcement** | **Reduced** disease-related **healthcare costs**<br><br>Avoided opportunity losses through better **water access** |
| Improve presence and access to **green areas and park areas** to improve **public health** and promote **healthy lifestyles** | Park or green areas **constructions** and **maintenance**<br><br>**Upgrades in community sports facilities** in parks | **Landscaping** and **infrastructure** works<br><br>**Materials** and **equipment**<br><br>**Labor** and **technical services** | **Flood risk reduction** through green areas.<br><br>Improved **air quality**<br><br>Healthcare cost savings from increased **physical activity**<br><br>Boosted local **tourism** |
| Develop a **shock-responsive social safety net** for **post-disaster recovery** | Increase in **The National Disaster Fund**<br><br>**Rehabilitation works** after a natural disaster<br><br>**Cash grants** in response to disaster recovery | **Labor, materials**, and **equipment** for repairs<br><br>Damage **assessments** and **logistics**<br><br>**Fund allocation** and **management**<br><br>**Disbursement systems** | **Improved livelihoods** and **infrastructure**<br><br>Faster **community recovery**<br><br>Strengthened disaster **preparedness** and **response capacity** |
| Strengthen **vector-borne disease surveillance** programs | **Activities** to prevent the **post-hurricane spread** of vector borne diseases<br><br>Provision of **mosquito nets** | **Activities** to prevent the **post-hurricane spread** of vector borne diseases<br><br>Provision of **mosquito nets** | Healthcare cost **savings**<br><br>Increased **community awareness** and **protection**<br><br>**Reduced** disease **transmission risk** |
| Implement the **National Financial Inclusion Strategy** to improve livelihoods and reduce vulnerability through greater **financial access.** | Implementation of the **Livelihood Protection Policy** (LPP) | **Data systems** for enrollment and claims<br><br>**Monitoring** and **evaluation activities**<br><br>**Administrative setup** | **Improved financial resilience** for vulnerable households during shocks or disasters. |

**Figure 27. Specific actions, costs and benefits corresponding to the population and health sector.**

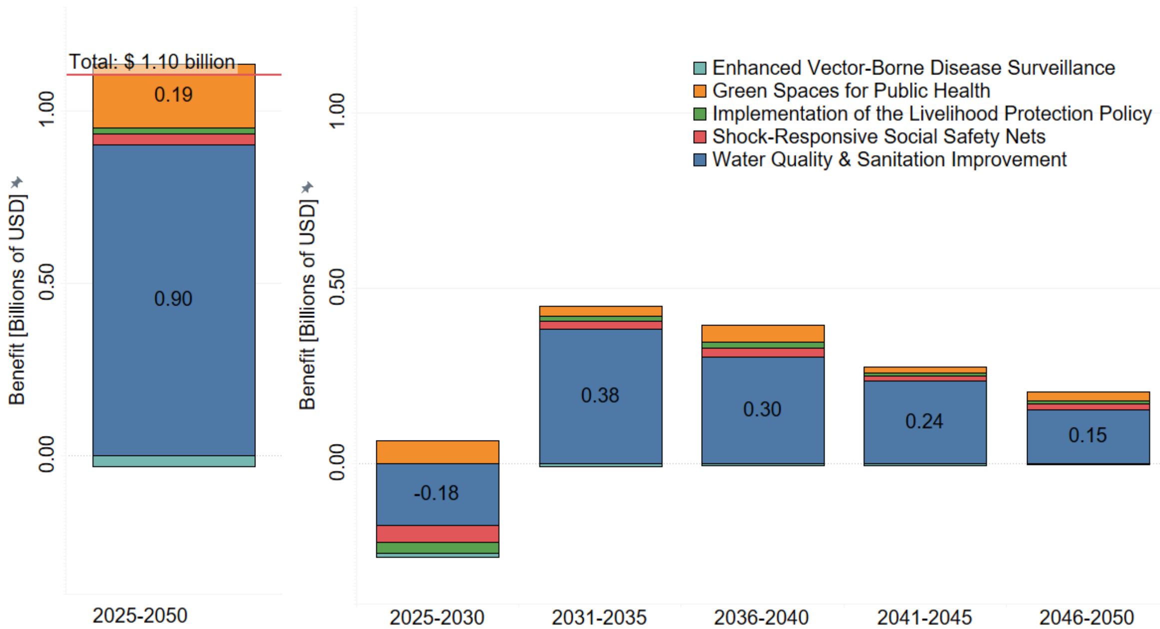
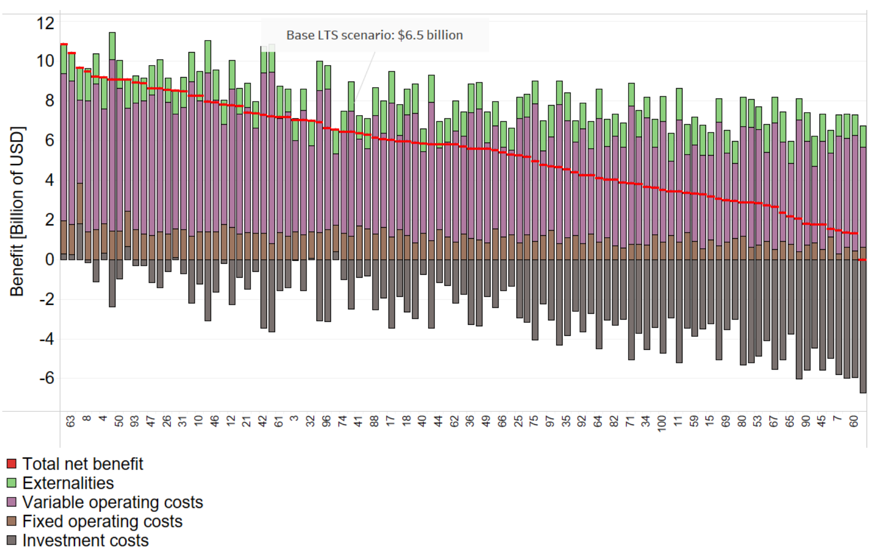


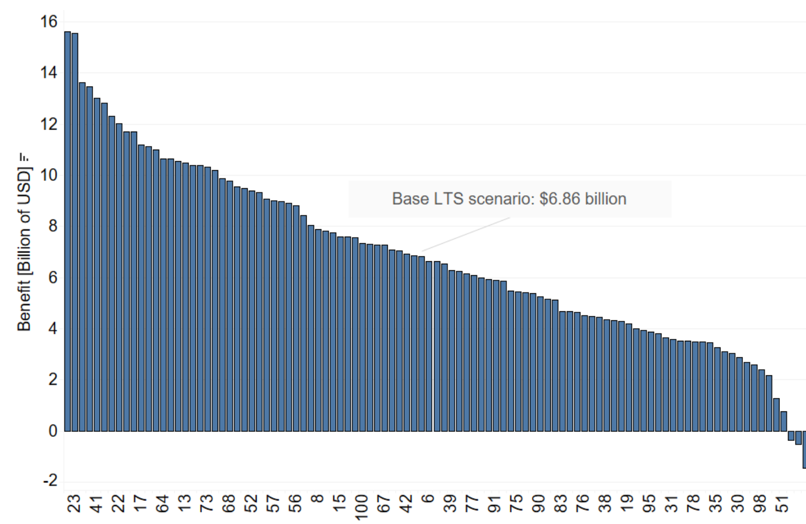

**Figure 28. Costs and benefits associated with the population and health sectors.**

# 4 Impact of uncertainty on costs and benefits

The cost-benefit analysis of the actions outlined in the LTS, relative to the baseline scenario, has been estimated to be at least USD 13.9 billion for the period 2025–2050. To assess the resilience of LTS under varying future conditions, a structured experiment was conducted involving multiple plausible futures. A total of 100 additional future scenarios were evaluated. These futures incorporate both exogenous and endogenous uncertainties, including changes in investment and operating costs, variations in the technological mix required to meet targets, and uncertain future demand trajectories. It was further supported by the application of the Patient Rule Induction Method (PRIM), a data mining algorithm used to identify favourable decision spaces. The objective of this work is to identify robust pathways—those that consistently yield high benefits across a wide range of uncertain futures—comparable to the core LTS scenario. Figure 29 illustrates the range of economic benefits in the experiments.  It is important to note that in all modelled scenarios, the implementation of the LTS will result in a net-benefit for Jamaica.




(a)

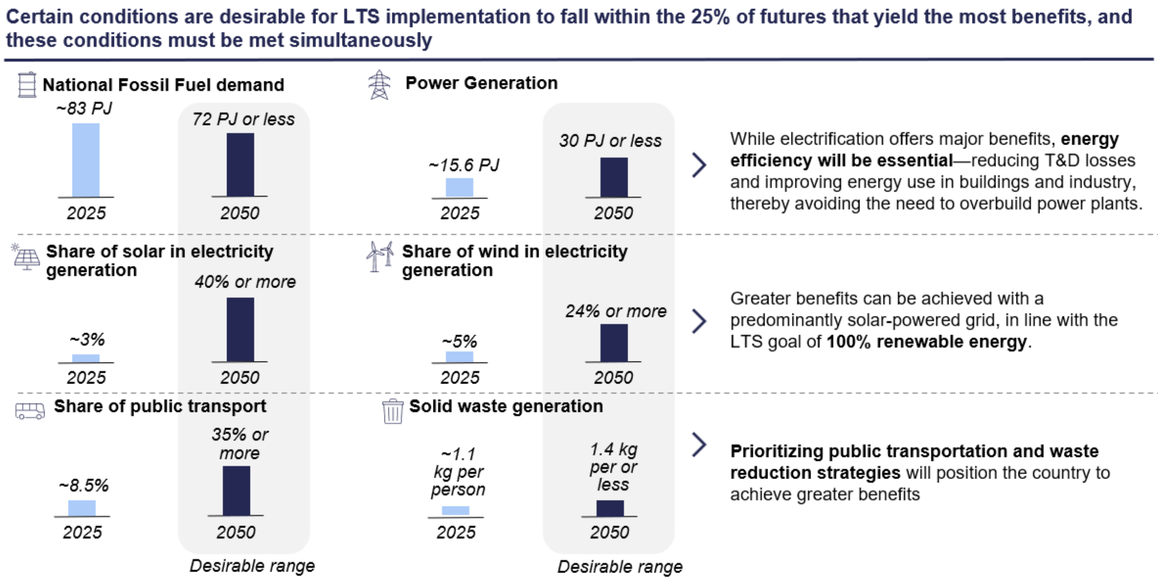



(b)

**Figure 29. LTS scenario variations evaluated under uncertainty, (a) mitigation and (b) adaptation actions.**

An analysis of the experiment results shows that the top 25% of futures of mitigation actions in terms of benefits share a set of conditions identified as particularly relevant. While the exploration of how costs and benefits change under uncertainty was carried out for both mitigation and adaptation actions, this part of the analysis was applied only to mitigation. The reason is that this analysis leverages the integrated nature of the OSeMOSYS model, which captures the interlinkages among sectors, technologies, and system dynamics. In contrast, the CBA for adaptation actions follows a simpler approach that does not rely on detailed sectoral modeling. Instead, each adaptation measure is assessed without accounting for systemic interactions. These conditions are illustrated in Figure 30 and the key takeaways are summarized below. These are the conditions highlighted as the most important by the analysis in order to maximize the benefits it accounts for:

- Boosting energy efficiency across all sectors is especially important given the uncertainty surrounding Jamaica's future electricity demand, particularly in light of the targeted electrification. Implementing efficiency measures will help ensure that the future need for renewable power plants does not become so large that it makes the energy transition more costly, thereby reducing the perceived benefits. The analysis indicates that, to maximize the benefits of the transition, fossil fuel demand should fall to 72 PJ or less by 2050 (from ~83 PJ in 2025), and electricity generation should be limited to about 30 PJ or less by 2050 (from ~15.5 PJ in 2025).
- It will be essential to build an electricity system dominated by renewable sources, particularly solar and wind, which are expected to play a central role in meeting long-term goals. The current renewable energy target is critical for maximizing benefits. The analysis indicates that solar and wind should account for at least 64% of total electricity generation by 2025, compared to their current contribution of less than 10%. Complementary technologies such as energy storage will support system flexibility as these variable sources expand.
- Encouraging a shift towards public transportation, from ~8.5% of all transport to 35% or more, is a crucial step in reducing private vehicle dependency. This action is particularly important, as buses are more efficient at transporting larger groups of people. Additionally, promoting alternative, non-motorized modes of transport—such as walking and cycling—supported by smart urban and territorial planning, will further strengthen the transition to a more sustainable, low-carbon mobility system.
- Finally, limiting the growth of the total amount of solid waste Jamaica needs to manage to no more than 1.4kg per person annually by 2050 (from ~1.1kg in 2025) can result in significant savings. These include lower investment and operating costs, as well as reduced healthcare expenses associated with direct or indirect exposure to waste.




*Note: All variables are within the desirable range for the LTS modeled scenario. 2025 values are estimated using the most recent data available.*

**Figure 30. Relevant desirable conditions for achieving high benefits through LTS actions.**

# 5 Macroeconomic impacts of implementing the LTS

The Cost-Benefit Analysis (CBA) performed through the implementation of OSeMOSYS models assesses mitigation and adaptation actions independently. However, LTS measures interact in the broader economy as they require mobilizing investment flows and some of the labour force, and some of them have consequences on the prices of essential commodities like energy (electricity and refined fuels) but also cement or transportation services.

To assess such interactions and capture feedback effects from all economic markets, the central results of the CBA were aggregated and used as inputs to the KLEM macroeconomic model, carefully calibrated on and adapted to the specifics of the Jamaican economy as KLEM-JAM (see Annex A). The following section a. presents KLEM-JAM results on the aggregate macroeconomic impacts of the LTS. Section b. then applies 'input-output' methods to break down KLEM-JAM results by activity sector, providing insights on how the LTS is likely to affect different areas of Jamaican economic activity.

## A. Estimated LTS impact on macroeconomic indicators.

KLEM-JAM computes macroeconomic feedbacks that reflect the improvement of the cost-benefit balance of mitigation and adaptation measures over the long run, when major investment requirements have been met. After starting broadly in line with BAU, LTS thus slowly increases GDP to bring it 5.9% above BAU in 2050 (Figure 33). The gap corresponds to a modest but meaningful 0.2 points increase of the 2021-2050 average annual growth rate from 1.98% to 2.18%.

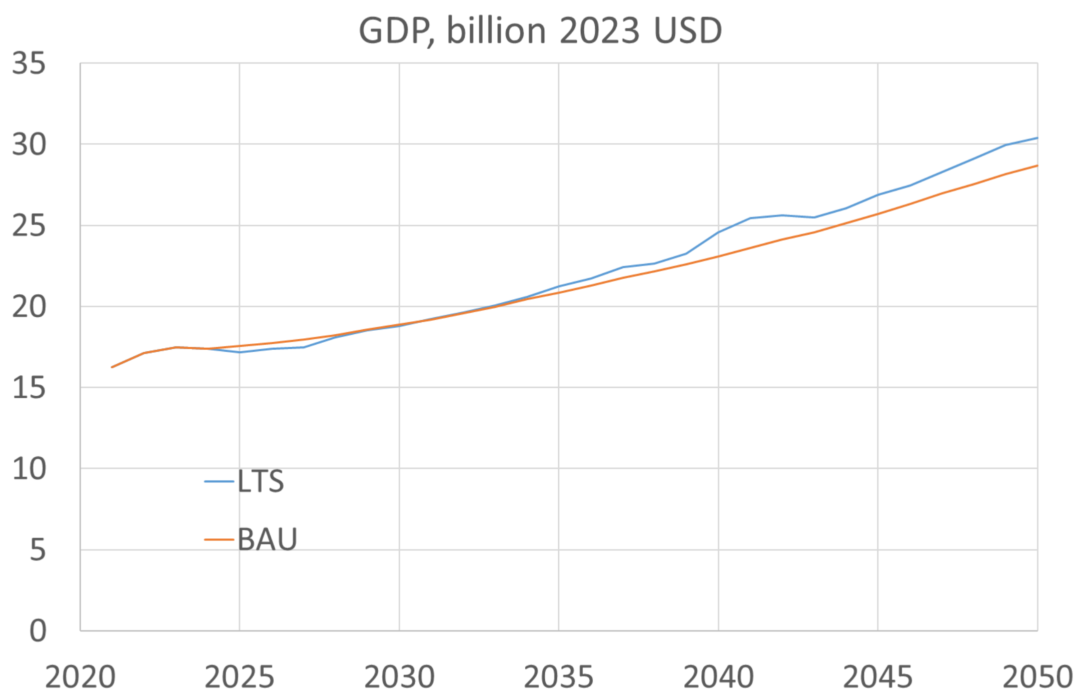



**Figure 31. GDP projections by KLEM-JAM, 2 scenarios.**

In the earliest years of the transition, from 2025 to 2030, the significant investment efforts identified by OSeMOSYS as necessary to set in motion long term transformations induce a GDP lag that culminates at 2.6% in 2027.  The lag translates in a more moderate increase in unemployment of 0.8 to 0.9 points, as the strong capital requirements of the LTS favor more labour-intensive activities (Figure 33). However, the progressive shift of the cost-benefit balance towards net benefits allows unemployment to start decreasing before 2030: the increasing saved net expenses induce activity gains that mobilize part of the workforce remaining idle under the BAU assumption of stable unemployment from 2023 on. The following section b. details the sectoral composition of that activity increase.

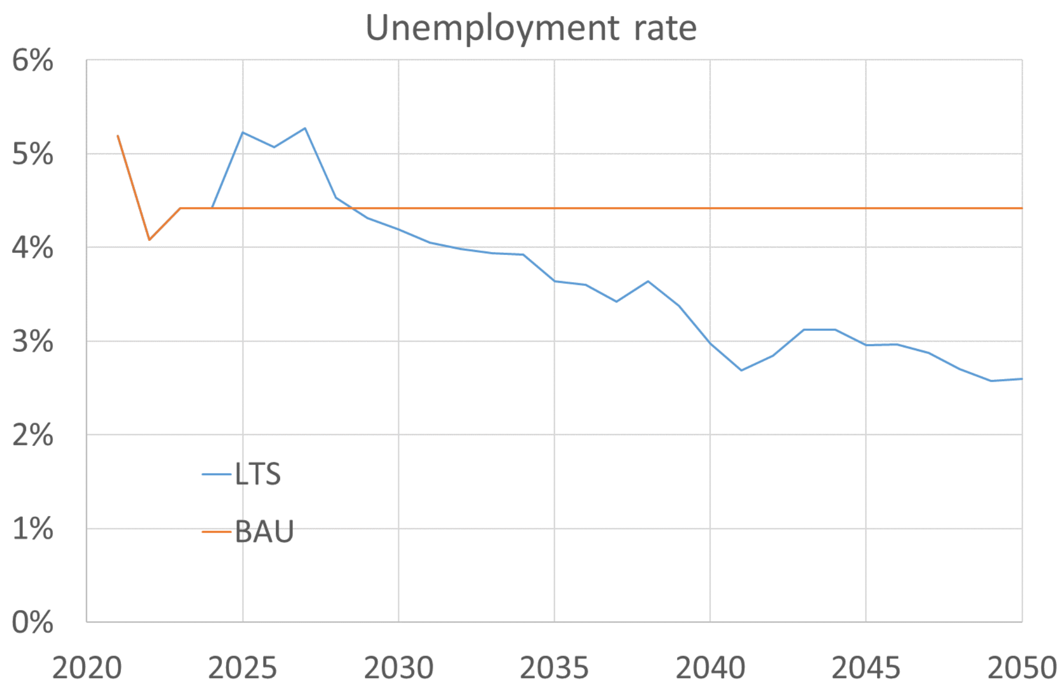



**Figure 32. Unemployment projections by KLEM-JAM, 2 scenarios.**

For the same reasons, compared to BAU[5], the LTS also decreases in the short term (by up to 3% in 2027) then increases in the longer term the aggregate volume of output or production of ‘materials’ or non-energy i.e. all goods and services other than energy, another indicator of economic activity. Non-energy output ends up 3.9% above BAU level in 2050 (Figure 32, a). Again, section b. offers insights into the sectoral composition of that aggregate surge.

[5] BAU unemployment is maintained at 2023 level by the adjustment of a trade shock opposingly affecting non-energy exports and imports (see Annex a).

Importantly, our estimation of the short-term consequences of the upfront investment requirements backing the LTS are conditional upon two major modelling assumptions regarding the balance of investment and savings. The first is that LTS investments only partially crowd out general productivity investment. For lack of information, we assumed that half of the investment flows of mitigation and adaptation measures as pinpointed by OSeMOSYS replace general productivity investment, while the other half accrue from increased savings. This first assumption may be viewed as mitigating the activity consequences of the LTS by allowing the aggregate national investment effort to increase, rather than to remain capped at BAU level.

The second assumption is that the increased savings that allow the increased investment effort are of Jamaican source. This means that Jamaican households are supposed to increase their propensity to save to invest into the LTS, e.g. because of fiscal incentives compensated by increased consumption taxes—with returns that materialize as early as 2030, when the LTS GDP catches up on its BAU counterpart (see Figure 31).

However, increasing the share of households' income directed to savings comes at the cost of reducing the share directed to consumption. The consequence is that the progression of households' consumptions other than energy (Figure 32, b) is significantly stalled by the LTS in early years, by up to 5.7 % in 2025. Even after unemployment (in 2028) then general activity (in 2031) overcome BAU levels, non-energy household consumption remains hampered by the continuing extra saving effort. It is only after 2038 that increased economic activity and decreased investment needs combine to bring it above BAU levels. The gain then rises steadily to end up at 6.4% in 2050, surpassing both the GDP gain (barely) and the non-energy output gain (more significantly).

In summary, while the implementation of Jamaica's LTS requires significant upfront investment that comes at some macroeconomic cost, it is projected to lead to stronger economic performance—higher GDP, more employment, larger output, and increased household consumption—in the long run.

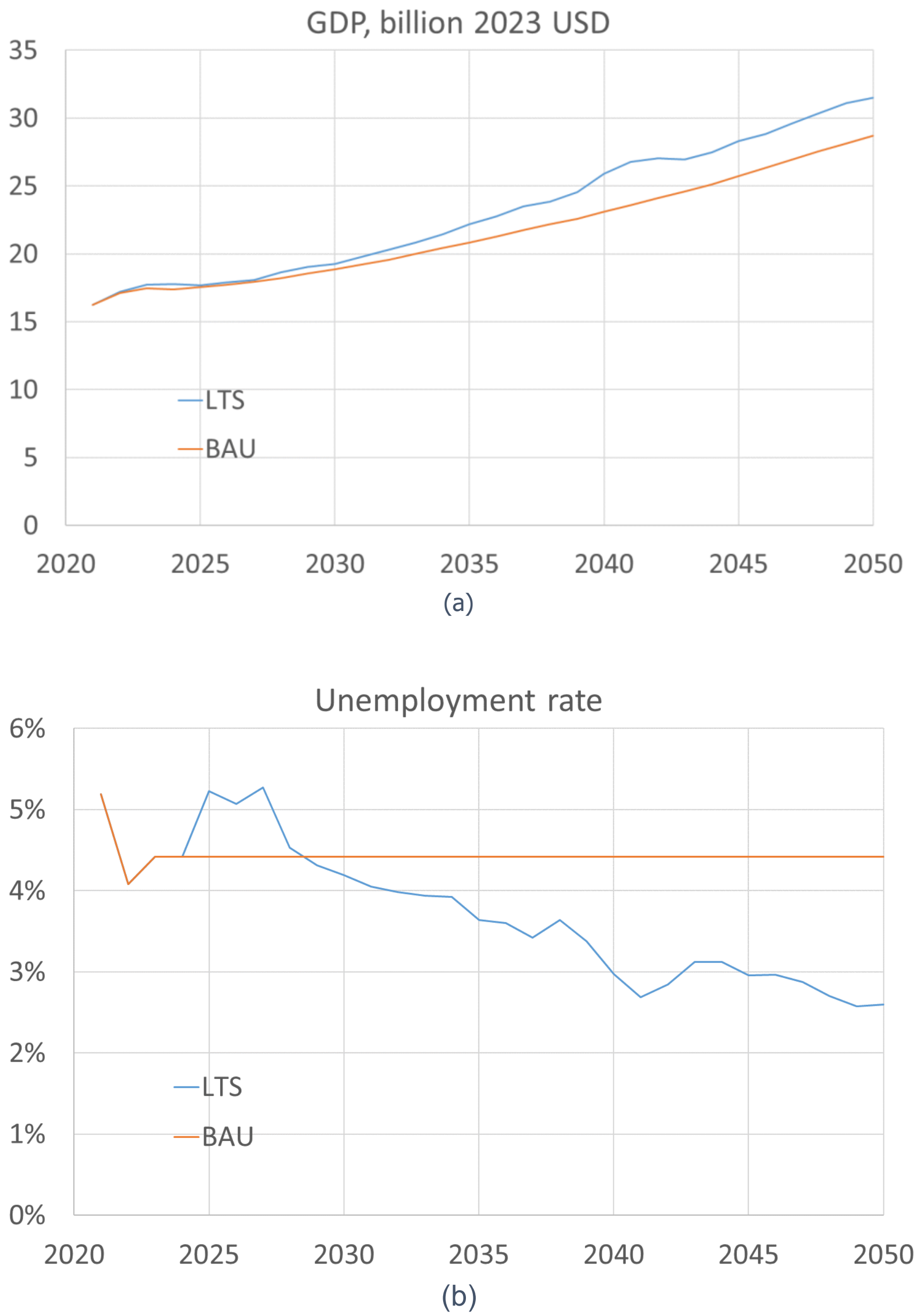
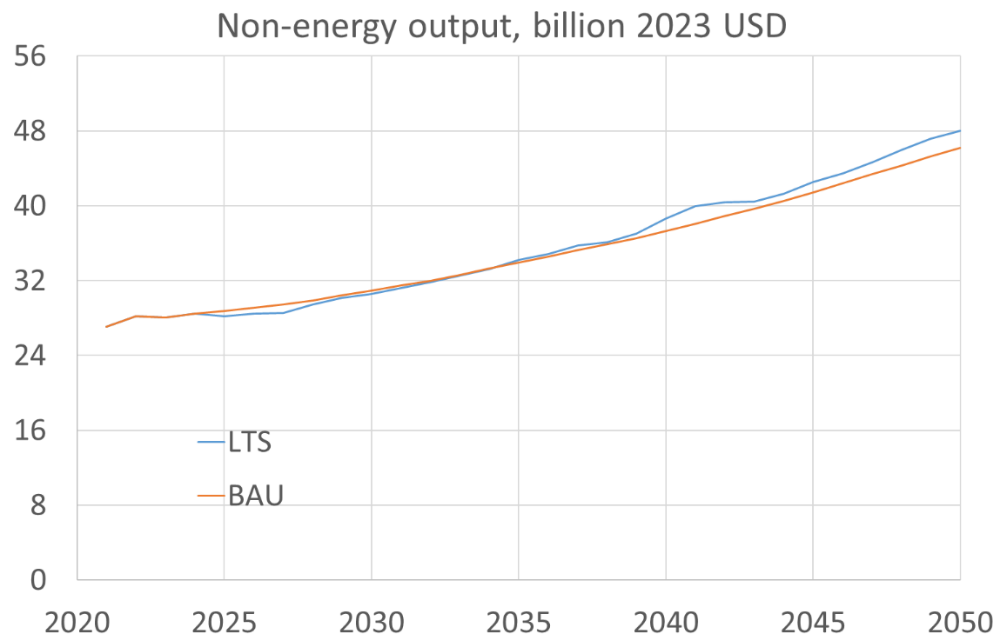
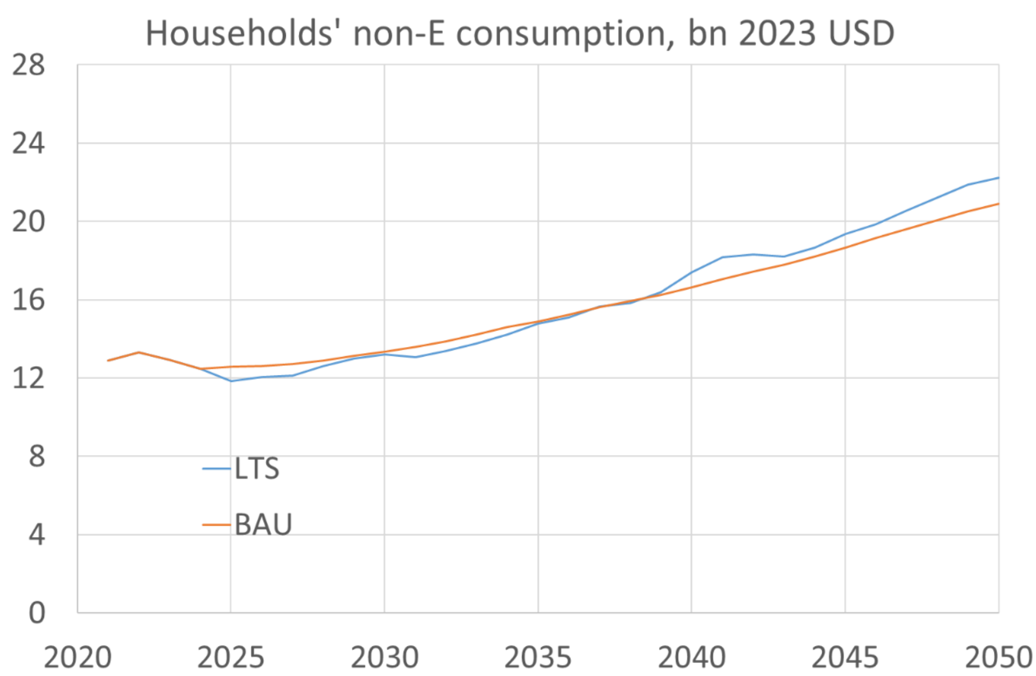



**Figure 33. Projected GDP and unemployment under two scenarios using the KLEM-JAM model. Results are shown for a Business-as-Usual (BAU) scenario and a Long-Term Strategy (LTS) scenario, both calibrated using the results generated by the OSeMOSYS model. The two scenarios share the same assumptions up to 2025. The BAU GDP corresponds to the GDP trajectory used in the OSeMOSYS projections. In the BAU scenario, the unemployment rate is held constant at its 2023 level by applying an offsetting trade adjustment that affects non-energy exports and imports in opposite directions (see Annex a).**



(a)



(b)

**Figure 34. Non-energy output and household consumption projections by KLEM-JAM, 2 scenarios.**

## B. Sectoral implications

The use of input-output (I/O) multipliers for economic impact assessment shows that the effects of LTS investment spending go well beyond the initial outlay. Direct impacts are seen in jobs, income, and output in industries carrying out projects such as renewable energy, resilient infrastructure, or ecosystem restoration. These direct effects create indirect impacts as related industries supply goods and services to support the projects, and induced impacts as workers across the value chain spend their earnings on local goods and services. Together, these ripple effects mean that each dollar invested in LTS initiatives stimulates wider economic activity across the multiple sectors in the Jamaican economy which then magnifies the overall contribution to employment, income, and GDP.

Specifically, Figure 33 quantifies these dynamics and shows the total net impact on GDP between the LTS and BAU scenarios by 2050 for each sector which is further disaggregated into direct, indirect, and induced effects. **Figure 35** By 2050, the LTS scenario is projected to contribute USD 1.7 billion or 5.9% more to Jamaica's GDP (in 2023 USD) relative to the BAU scenario.

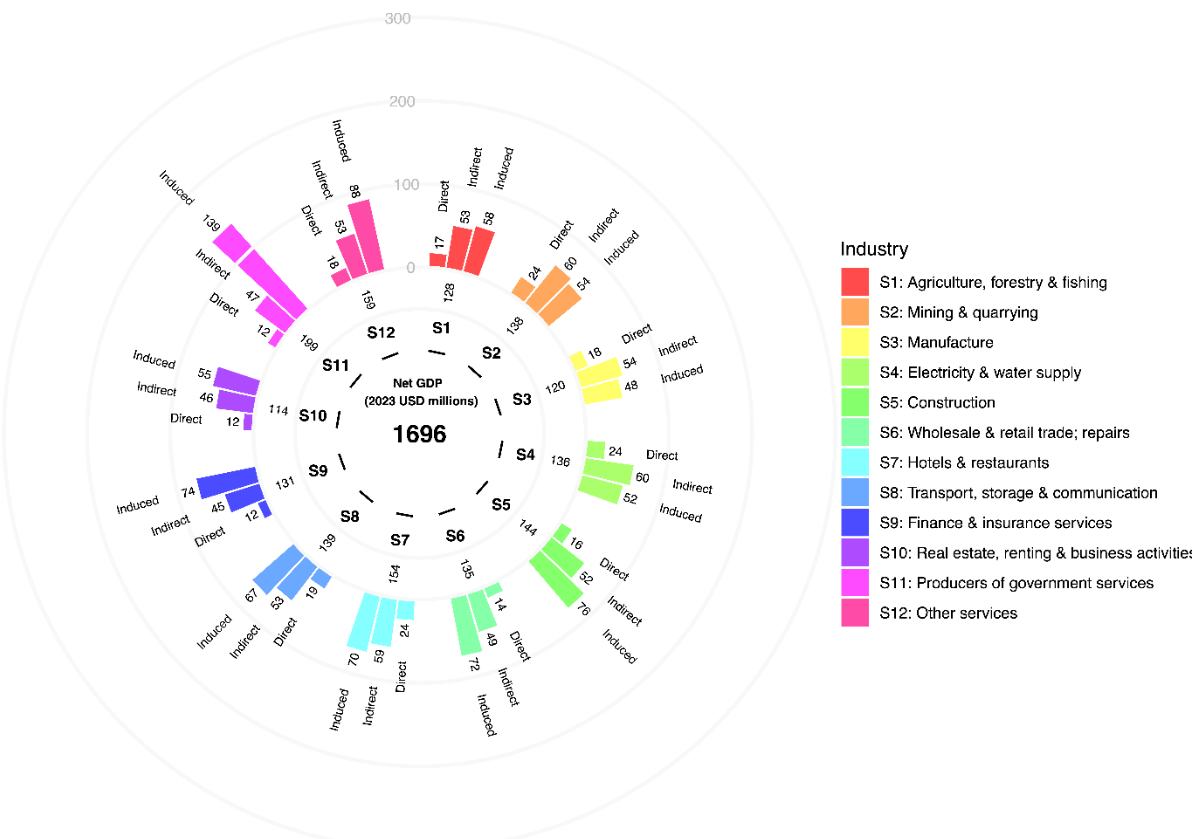



**Figure 35. Net GDP Difference between LTS and BAU Scenarios by 2050, by Sector.**

The Government Services sector accounts for the largest portion of this net GDP gain, contributing around 12 percent (USD 0.2 billion). This increase is driven primarily by induced effects (USD 0.14 billion) from higher household incomes and greater consumption, supported by indirect effects (USD 0.05 billion) through spillovers to related industries, and direct effects (USD 0.01 billion) from public investment and employment growth.

The Hotels and Restaurants sector also benefits substantially from LTS investments, contributing approximately 9 percent of the overall gain. This is largely due to targeted interventions, such as investments in infrastructure and climate adaptation, which enhance the sector's long-term performance by strengthening resilience to coastal erosion and extreme weather events, promoting renewable energy and water efficiency in hotel operations, and improving disaster preparedness. In comparison, sectors such as Real Estate, Renting, and Business Activities provide a smaller contribution to net GDP gain, at around 7 percent. The observed lower impact on this sector is partly due to its capital-intensive structure and relatively limited employment responsiveness, which tends to reduce the scale of multiplier effects, even in the context of broader economic growth.

Overall, these results highlight the economic potential of climate-compatible public and private investment, particularly in sectors with strong linkages to employment and consumption. Understanding these sector-specific dynamics is critical for shaping inclusive and growth-oriented climate transition strategies.

In extending the analysis to employment, Figure 36 shows the projected net employment gains under the LTS scenario relative to the BAU scenario by 2050. Compared to the BAU scenario, the LTS is expected to generate approximately 26,000 additional jobs across 12 sectors, supported by a combination of direct employment, indirect supply chain effects, and induced job creation resulting from increased economic activity. For example, renewable energy and infrastructure projects not only create direct construction and operations jobs but also stimulate indirect supply chain employment in industries such as cement and steel production, equipment manufacturing, and professional services that support project delivery.

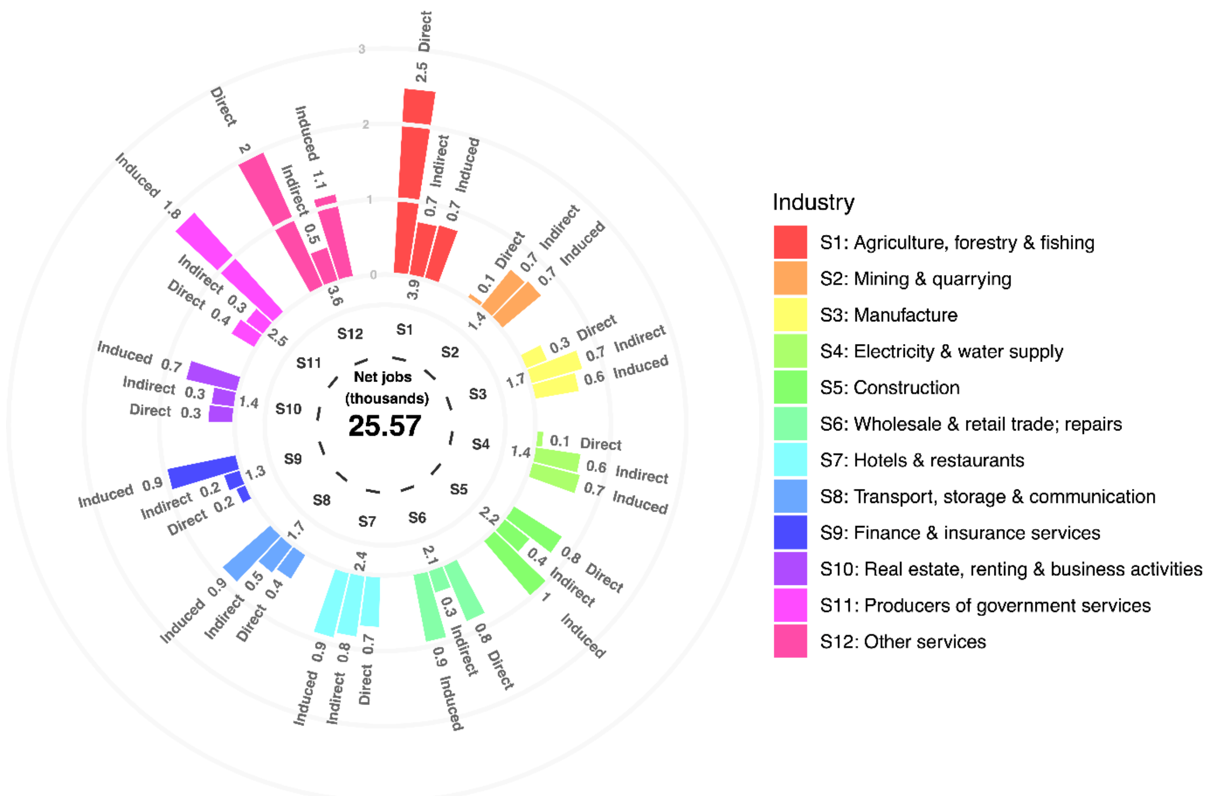



**Figure 36. Net Jobs Difference between LTS and BAU Scenarios by 2050, by Sector**

A significant share of the employment gains stems from induced effects, particularly increasing household consumption under the LTS scenario. Though the macro-level analysis shows that household non-energy consumption is temporarily constrained in the first decade due to higher precautionary savings and investment needs, the gains observed in the sectoral breakdown therefore mainly reflect the longer-term dynamics. After 2038, as economic activity strengthens and investment pressures ease, household consumption surpasses BAU and continues to rise. In other words, while household consumption temporarily lags in the early years, its recovery and subsequent expansion are key drivers of sectoral employment gains later in the period. This increased demand is expected to benefit labour-intensive sectors such as Wholesale and Retail, Government Services, and Tourism, reinforcing the importance of consumption-driven job growth.

The Agriculture, Forestry, and Fishing sectors emerge as the largest contributor to new employment, accounting for roughly 15 percent or about 3,900 of the total jobs created. This reflects both the labour-intensive nature of the sector and its alignment with climate adaptation and rural development priorities. Investments in improved irrigation, resilient crop varieties, and land management practices are expected to enhance productivity and expand employment opportunities in this sector.

By contrast, the Financial and Insurance Services sector contributes a smaller share of employment gains, estimated at around 5 percent. This limited impact is due to its high capital intensity and relatively weak backward linkages. For instance, banks and insurance companies rely more on digital platforms, software, and financial instruments than on extensive local supply chains for goods and services. As a result, their spending generates fewer spillover jobs in upstream industries compared to sectors such as construction or manufacturing.

Together, these findings underscore the overall positive employment impacts of the LTS implementation and highlight the value of considering direct, indirect and induced pathways to job creation when designing long-term economic and environmental policies.

### C. Fiscal implications

The LTS adopts a coordinated investment framework that is expected to leverage both public and private financing, consistent with international guidance. According to the United Nations Conference on Trade and Development (2014), it is estimated that the public sector finances approximately 80% of climate adaptation investments. This reflects the government's pivotal role in infrastructure development, disaster preparedness, and social protection. In contrast, climate mitigation investments tend to be more evenly distributed, with around 40% funded by the public sector and the remaining 60% mobilized from private sources especially in sectors such as renewable energy and energy efficiency.

After applying these investment proportions, Figure 37 illustrates the potential contribution of government financing to capital investments under the LTS. In 2024, public capital expenditure stood at 1.8 percent of GDP, slightly below the long-term average of 2.3 percent. If capital spending were to follow the normal projection path established under OSeMOSYS (red line), the government's share of LTS-related investment would peak at approximately 4.7 percent of GDP by 2039.

However, given the urgency of addressing climate change impacts, there is a strong case for accelerating some adaptation and mitigation investments. To this end, a LTS front-loaded investment approach (blue dashed line) is also modeled that shows public capital spending rising to nearly 4.9 percent of GDP in the early years. This ramp-up targets critical infrastructure, transportation, and energy system improvements needed to build resilience and support the LTS transition. When compared to the BAU scenario (grey line), which reflects historical patterns of government capital spending, this highlights the scale of effort required. Under the LTS, the government may need to at least double its capital expenditure share of GDP relative to current spending patterns to align investment levels with the LTS emissions reduction targets.

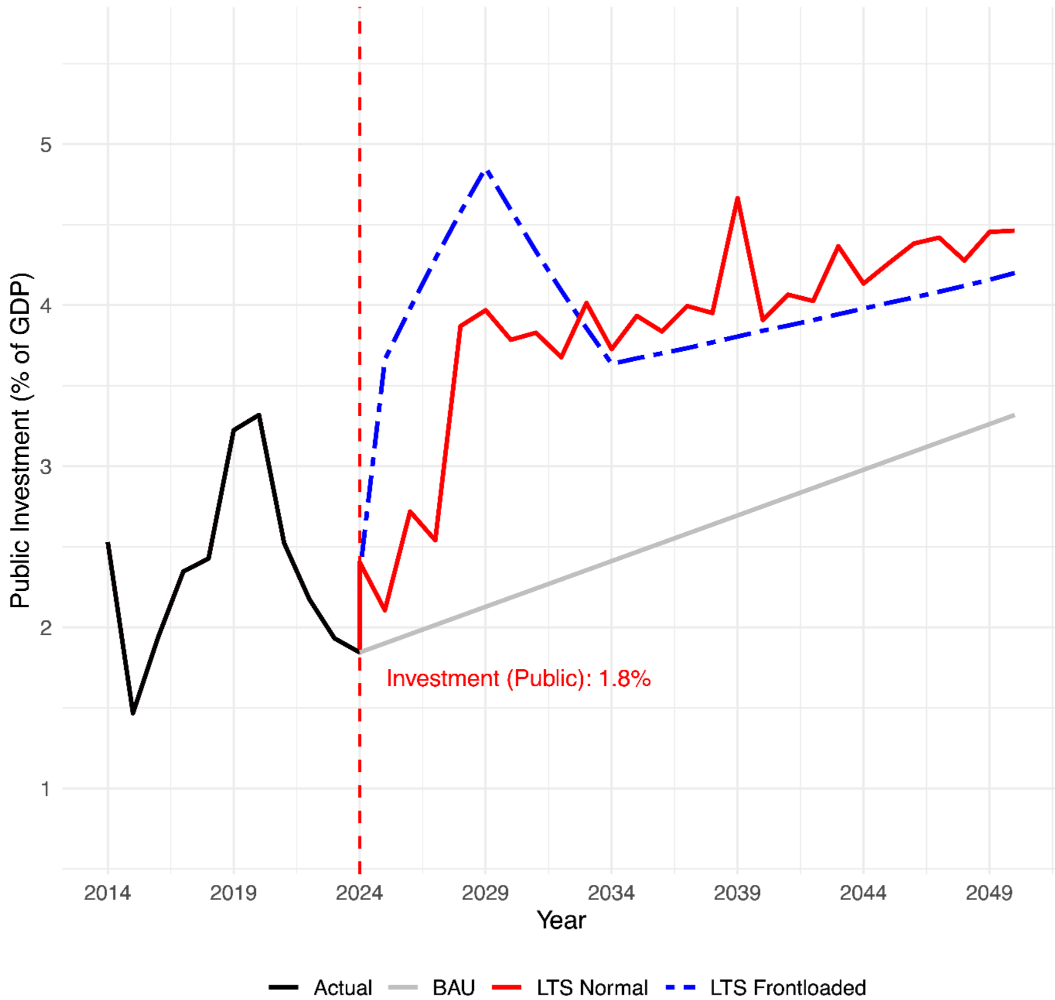



**Figure 37. Public Capital Spending as a Share of GDP, LTS vs. BAU (2024 - 2050).**

While the projected returns from LTS investments are significant as reflected in the positive impacts on GDP and employment outlined earlier, the government's commitment to scaling up capital spending could increase fiscal pressures, particularly if additional borrowing is required to finance its share of the investment. As a result, ensuring debt sustainability remains critical, especially in light of Jamaica's historical challenges with high debt service obligations.

As of 2024, the average effective interest rate on public debt stood at approximately 6.5 percent. Interest payments accounted for 5.4 percent of GDP, though the government-maintained a near-balanced fiscal position, with a deficit of just 0.2 percent of GDP which is an indication of prudent fiscal management. As shown in Figure 38, the public debt-to-GDP ratio under the LTS scenario is projected to decline modestly from 67.9 percent in 2024 to an average of around 66 percent over the 2024 to 2050 period, before falling slightly further to about 65 percent by 2050. This trajectory contrasts sharply with the BAU scenario, where the debt ratio falls more rapidly to about 39 percent by 2050. The higher debt ratio under the LTS reflects the significant public sector investments required to finance the transition, which entail additional borrowing in the near term. These investments are expected to stimulate stronger long-term growth, but they slow the pace of debt reduction relative to BAU. This also means that, without supplementary fiscal measures, the LTS path would not meet Jamaica's legislated target of reducing the debt-to-GDP ratio to 60 percent or lower by the 2027/28 fiscal year. Nevertheless, once the upfront investment phase eases and growth accelerates, the debt trajectory is expected to stabilize and remain manageable, provided fiscal policy continues to prioritize debt sustainability.

While the LTS approach entails higher initial borrowing, it supports a transition to a more resilient, low-carbon, and inclusive economy. The temporary increase in debt represents a deliberate trade-off to finance long-term gains in productivity, economic security, and climate resilience.

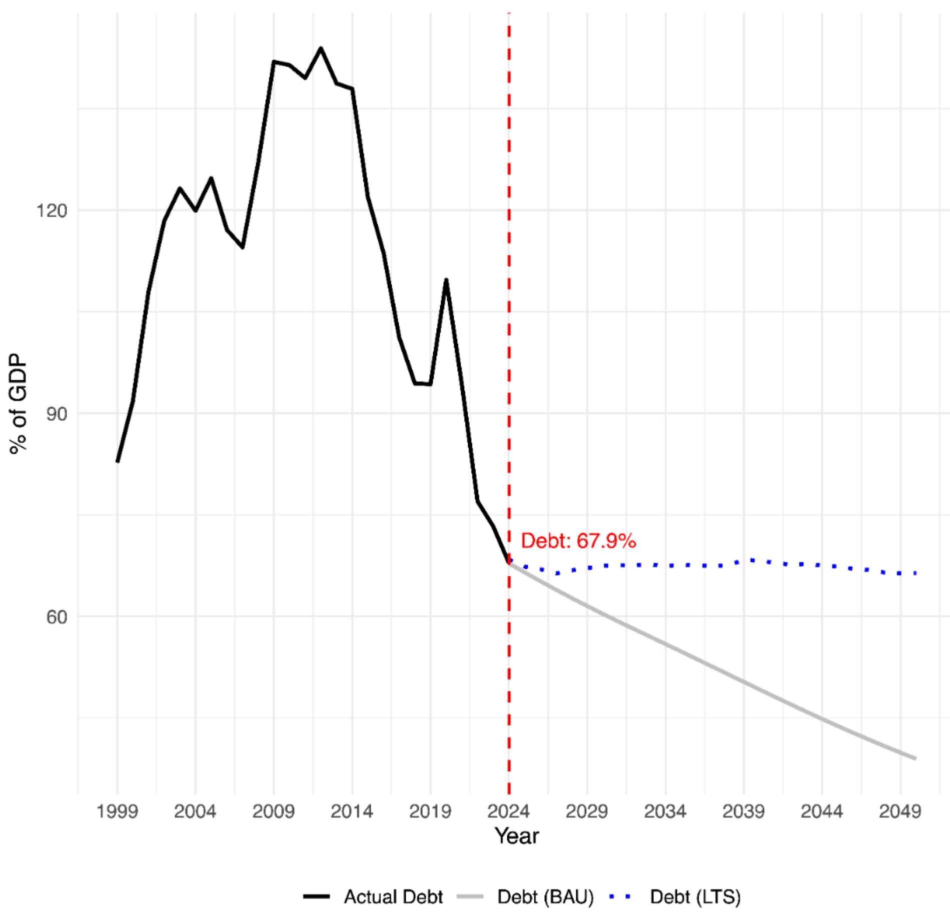



**Figure 38. Public Debt-to-GDP Ratio Projections, 2024–2050.**

# 6 Conclusions and recommendations

The results of the cost-benefit analysis (CBA) confirm that Jamaica's LTS is cost-beneficial, with the quantified benefits outweighing the costs across both mitigation and adaptation sectors. These results provide robust evidence in support of continued institutionalization, implementation and scaling of LTS-aligned actions. Specifically, the scenario with LTS implementation shows significant economic gains over the BAU scenario, amounting to $13.9 billion in direct net discounted benefits from 2025 to 2050, most of which come from the transport and critical infrastructure sector. The transformation in this sector is supported by changes in other sectors, such as the increase of power generation in the electricity sector. By 2050, it is expected to yield roughly USD 1.7 billion more GDP (undiscounted 2023 USD) and approximately 26,000 new jobs, all macroeconomic feedbacks (i.e., economy-wide effects that arise when a policy is put in place, a shock happens or an investment is made) taken into account. Government Services see the largest GDP gain (12%, USD 0.2B), mainly from higher household incomes and public investment. Hotels and Restaurants follow (9%), boosted by LTS investments that enhance resilience, efficiency, and disaster preparedness. Agriculture, Forestry, and Fishing create the most jobs (15%, ~3,900), driven by labor intensity and investments in resilience. Key recommendations include:

1. **Consider the interdependencies of LTS actions to optimise the cost of LTS investments:** Realizing the LTS's ambitious targets for transport electrification will require adequate investments in clean power generation and grid infrastructure. In this context, energy efficiency measures—such as those in buildings and industry—will play a pivotal role in reducing total electricity demand, ultimately lowering the scale and cost of energy infrastructure needed to support electrification across sectors. Formal coordination bodies or task forces could prevent siloed planning, ensure consistency in assumptions (e.g. electrification timelines), and align infrastructure delivery with sectoral needs. Similarly, as shown by the RDM analysis, setting the modal shift target in the transport sector to at least a 35% by 2050 of the mobility demand will be pivotal in maximizing the benefits of the LTS.
2. **Identify and align existing national initiatives with the LTS:** Despite the qualitative nature of LTS' adaptation objectives, Jamaica already has ongoing or planned national initiatives that align closely with them. This CBA involved an effort to identify the specific initiatives underway in the country in order to bring greater granularity to the adaptation goals outlined in the LTS.As such, it can serve as a foundation for future LTS updates, ensuring that strategy revisions are grounded in existing national experience and local priorities and progress on implementation of measures.
3. **Prioritize high-linkage sectors**: Since Government Services and Tourism are the largest GDP beneficiaries under the LTS, the public sector should scale up strategic investments (e.g. infrastructure, digital services, health and education) that raise productivity and create jobs. In Tourism (Hotels & Restaurants), support climate-resilient infrastructure (beach protection, flood-proof resorts) and invest in eco-tourism and marketing to boost demand. Encourage private investment (for example, via tax incentives or PPPs) in energy-efficient upgrades and climate-proofing for hotels and

restaurants. By strengthening these labour-intensive sectors, Jamaica can capture the multiplier effects of higher incomes and consumption noted in the analysis.

4. **Stimulate green job creation:** Policies should stimulate labour demand in the transition to low-carbon sectors. This includes funding public works and grants for renewable energy projects, reforestation, and coastal restoration, offer training programs and apprenticeships in solar, wind, energy efficiency, and sustainable tourism. For example, vocational courses in hotel management and construction will help Jamaicans fill the new jobs created in Transportation, Hotels/Restaurants, Government Services, and Retail sectors under LTS. Shock-responsive social protection (e.g. retraining funds) can ease the shift for workers from carbon-intensive industries. Overall, matching the `green skills' to emerging opportunities is crucial for an inclusive transition.
5. **Enhance backward and forward linkages:** Some sectors (Real Estate, Business Services, Finance) are capital-intensive and show limited employment spillovers under the LTS. The government can nudge these sectors to be more labour-engaged by encouraging local sourcing and services. For instance, require government-backed climate projects to hire locally or procure from small suppliers. Simplify regulations for small businesses and green startups in these sectors, so they expand jobs. These measures help unlock additional GDP and jobs even in traditionally less-responsive sectors.
6. **Lean on co-benefits to drive consumption:** The LTS analysis highlights induced growth where higher household incomes in the long run under LTS boost retail and services. Fiscal policy can amplify this by preserving or boosting social transfers, tax credits, or subsidized loans that raise household spending power in the short term. For example, a temporary consumption voucher or targeted tax cut could spur demand in Wholesale/Retail and Tourism, sustaining jobs as the green transition progresses.
7. **Front-load strategic infrastructure spending:** Jamaica should adopt the LTS's "front-loaded" investment approach to raise public capital spending quickly to the approximately 4.9% of GDP in early years by focusing on climate-resilient infrastructure (roads, ports, water systems) and green energy grids. The OECD notes that "the right type of infrastructure investment can help enhance the quality of growth, by supporting climate action…while protecting biodiversity and reducing pollution" (OECD, 2024). Policymakers should ensure these projects are well-planned and high-impact, to maximize the returns in GDP and employment without waste.
8. **Mobilize private finance and manage fiscal risk:** Given Jamaica's debt constraints, encourage private funding especially for mitigation: offer tax incentives or guarantees to attract renewable energy and efficiency projects. Use climate bonds or blended finance so that international climate funds share risks on large projects. The OECD emphasizes unlocking private resilience finance through "effective risk-sharing arrangements and…targeted public support" (OECD, 2024). In practice, Jamaica can expand public–private partnerships in tourism development or energy, backed by concessional loans or insurance from development banks. At the same time, this requires maintaining fiscal prudence by sequencing borrowing to ensure debt/GDP peaks are kept under control (as in the LTS path, 68% peak vs much higher historical levels); and strengthening debt-

management policies, for example, refinancing existing debt to longer maturities so that interest costs are kept low.

9. **Align budgets with climate goals:** Make climate finance a line item in the national budget and Medium-Term Fiscal Framework. This enhances accountability and ensures resources support LTS targets. Gradually increase revenues (e.g. environmental levies) earmarked for adaptation projects, to share the fiscal load. Any revenue instruments should be designed to protect low-income households (e.g. rebates or transfers) to keep the transition equitable.
10. **Leverage international support and partnerships:** Jamaica's high climate vulnerability means it will need external help. The government should actively seek grants and low-cost loans (e.g. from the Green Climate Fund, IMF Resilience and Sustainability Trust, Caribbean Development Bank) for key infrastructure projects. The country should also engage in "new forms of international partnerships" and tap development banks to mitigate financing constraints. For example, exploring co-financing schemes could reduce the fiscal burden while creating jobs and growth.
11. **Carefully plan the phasing out of carbon-intensive industries to minimize disruption while expanding green sectors.** This requires earmarking part of the green infrastructure workforce training for parishes most affected by industrial decline (e.g., shifting from fossil fuel power to renewables). Social programmes and targeted reskilling initiatives can help displaced workers transition into emerging sectors, cushioning the short-term rise in unemployment outlined in the analysis. By embedding support for workers and communities at the centre of the LTS, Jamaica can build public support and ensure that job displacement remains manageable during the transition.
12. Throughout the stakeholder engagement process, it became clear that **demonstrating the technical feasibility of achieving 100% renewable power and expanding mangrove cover will be essential to increase ownership of the strategy among stakeholders**, as these were key questions raised during workshops. Addressing these issues will require more in-depth technical analyses beyond the scope of this CBA. In addition, while adaptation-related assumptions and targets were validated during the process, this remains an open question within the LTS. Establishing and institutionalizing adaptation targets would not only help deepen the understanding of LTS costs and benefits but also provide clear direction for the sectors moving forward.

The cost-benefit analysis and macroeconomic review indicate that Jamaica's Long-Term Strategy (LTS) should prioritize climate-smart investments and targeted incentives that directly benefit household-level economic activity, particularly in vulnerable communities. The evidence presented above demonstrates that strategic, climate-aligned mitigation and adaptation investments yield substantial net benefits, including measurable increases in GDP and employment in aggregate and at the sector level. With prudent debt management and private-sector engagement, Jamaica can finance this transition and reap long-term gains in productivity, resilience, and inclusive growth.

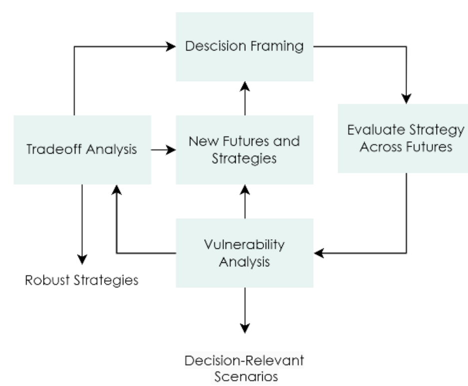
# Annexes

## A. Methodology

### 1. Robust-decision making

This project used the well-established Robust Decision-Making (RDM) methodology. It is a flexible and adaptable approach that has been successfully applied in various contexts to assist governments in designing or assessing robust policies. RDM is a framework to explore diverse goals from multiple stakeholders. It is a highly participatory and iterative framework that uses modelling tools to guide the discussion with stakeholders. Figure a.1 present the general workflow of the methodology.

**Figure A1: Iterative Steps of Robust Decision Making**




RDM can identify policies that provide benefits from multiple perspectives; for instance, policies to reduce emissions and approach net zero in under three decades while enhancing the resilience of the country and become energy independent. This increases the acceptance of the analysis and helps creating awareness of possible trade-offs. RDM consists of five general steps:

| | |
|---|---|
| 1 | The first step is the **decision framing** of the problem, where stakeholders deliberate and develop a shared understanding of the policy problem. Because it is ingrained in RDM, when framing the decision problem, stakeholders are compelled to think in the long term while identifying decisions to make in the short and medium terms to achieve goals. We started with an XLRM matrix: X: Exogenous uncertainties, L: Policy levers, R: Relationship and Models, and M: Performance metrics. |
| 2 | Second, the possible decisions to achieve the goals or strategies are evaluated across **multiple futures** by computing performance metrics. The numerous futures are necessary to capture the uncertainties that can affect the economy because of the long-term scope of the LTS. |
| 3 | Third, a **vulnerability analysis** investigates which uncertain conditions prevent the LTS from meeting the stakeholders' goals. Defining whether goals are met will depend on the performance metrics. |
| 4 | Fourth, there is **deliberation**, where stakeholders compare strategies. Often, strategies will have good performance in one metric and poor performance in another. In this project, the LTS is a strategy with multiple measures we can compare and assess with multiple metrics performance. |

| 5 | Fifth, **new futures and strategies** can be produced after stakeholders have learned about metrics, vulnerabilities, and trade-offs. The iteration consists of adjusting the decision framing (first step) to consider new actions, uncertainties, or metrics of interest. |
|---|---|

### B. Sectoral modelling and cost-benefit analysis: The OSeMOSYS model

The modelling exercise had two main components. The first component was building techno-economic models. These models effectively link costs and benefits in an internally consistent way from a physical perspective. They are often used for mitigation analysis. These models are sufficient to estimate costs and benefits for specific long-term scenarios, with yearly detail and relatively high technological detail. Our models will be based on the OSeMOSYS (Open Source Energy MOdelling SYStem) framework (Godínez et al., 2020; Howells et al., 2011).

Technoeconomic modelling enables the generation of multiple simulations to account for uncertainty implied in long-term economic transformations and make the estimations not simply rely on best guess values of parameters. Through the generation of multiple simulations, a range of costs and benefits are estimated.

We initially built sectoral models for each mitigation sector. Together, the models created the national model, to be named OSeMOSYS-JAM. Crucially, the models were used to generate metrics that allow the Government to gain buy-in for the measures. The included costs and benefits were validated in stakeholder processes. The sectoral OSeMOSYS modelling, along with the RDM framework can be visualized in Figure a.2.

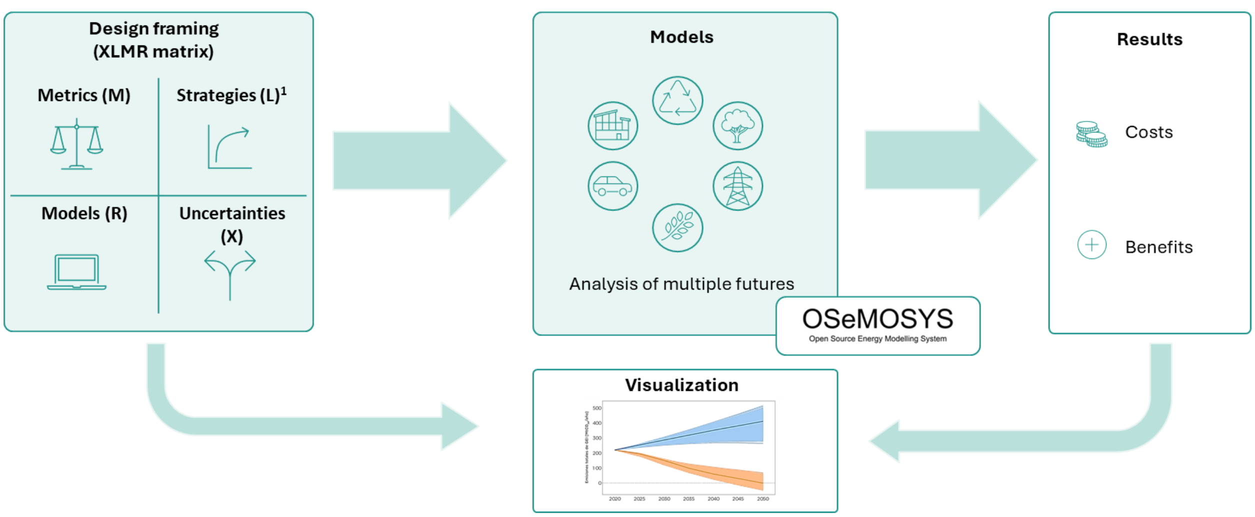



**Figure A2. Coupling of RDM and sectoral modelling.**

Given the differences between adaptation and mitigation, these two groups of strategies are structured differently in the LTS. The mitigation chapters focus primarily on quantitative actions with specific targets, while the adaptation chapters outline broader qualitative goals. As a result, adaptation actions required an additional step prior assessing their costs and benefits. As a first step, the project connected the LTS's broader climate adaptation goals to specific plans, targets and initiatives that sectoral entities are implementing or plan to implement. By breaking down these overarching adaptation objectives into more granular, actionable strategies, it was possible to evaluate their economic impacts by aligning them with measurable outcomes. Then, a simple cost-benefit calculation was performed for each action using spreadsheets. The outcome of this adaptation analysis is given in terms of the incremental investments and savings incurred when the LTS is implemented. Then, the effect of uncertainty was also analyzed by implementing RDM in these models. Figure 3.a describes this process.

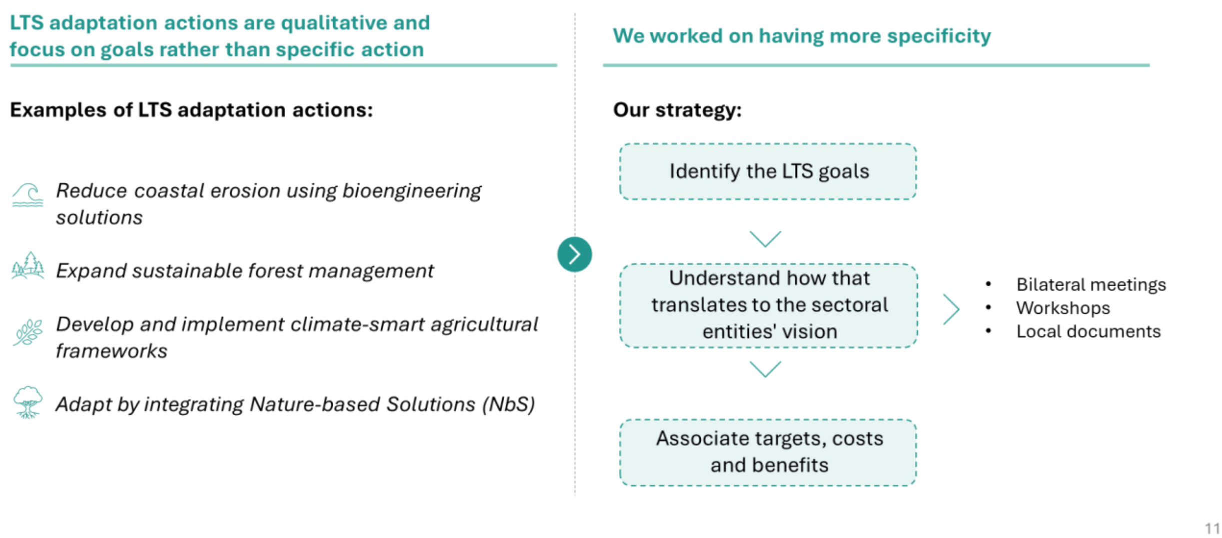



**Figure A3. Modelling approach for adaptation measures.**

## 2. KLEM-JAM model

As its name conveys, the KLEM macroeconomic model pictures economies through the description of two primary factors capital (K) and labour (L), and two products energy (E) and the remainder of the economy (non-energy goods and services or 'materials' M). That level of aggregation is meant to focus KLEM's analyses on overall macroeconomic impacts while maximising the ability to interpret modelling results. Its main limitation is to overlook the influence of structural change within the 'Materials' (hereafter 'non-energy') sector.4

KLEM generates dynamic, recursive macroeconomic models deriving from the Solow-Swan growth model, i.e. picturing economic growth as driven by exogenous assumptions on labour supply and productivity, as well as, for most KLEM versions, on the investment rate i.e. the share of GDP that is devoted to the building up of the physical capital stock.

The vector of energy and non-energy outputs at year $t$, $Y_t$, is a function $f_t$ of the stock of capital $K_t$, of the labour force $L_t$, and of the intermediate consumption of energy and non-energy goods. The $t$ index to function $f$ conveys that $f$ varies with time via exogenous factor productivity gains. Capital stock dynamics follow the standard accumulation rule $K_{t+1} = (1 - \delta) K_t + I_t$ with $\delta$ the depreciation rate. Investment $I_t$, the gross fixed capital formation (GFCF) of national accounting, is the amount of non-energy output used to build up the capital stock at period $t$.

Beside the above general features, the KLEM approach builds on two core methodological principles: (1) It recognizes the importance of combining the economist's and the engineer's view of energy systems through 'hybrid' modelling. (2) Rather than abiding by one single economic paradigm, it offers a variety of market specifications and macroeconomic closures from which to choose.

KLEM's 'hybrid' take on modelling translates in the fact that it is designed to be coupled to 'bottom-up' (BU) models or expertise of the energy system. The coupling is meant to happen through the iterative exchange of modelling results up to convergence. The exchange focuses on the energy system variables (prices and physical flows), forced into KLEM from the BU model, and on macroeconomic energy demand drivers (real GDP or output) as well as, in some country applications, relative price changes, fed back from KLEM into the BU model.

More specifically, considering its format KLEM traces the growth trajectory compatible with five energy flows aggregated from the BU model (see below) and the corresponding set of average, flow-specific prices, which it translates into average energy supply cost variations as well as variations of the specific margins (deviations of consumer prices from average supply costs) levied on each energy use. These constraints on energy volumes, costs, and prices affect economic growth and non-energy consumption, as part of the value-added is attributed to energy expenditures and energy efficiency costs, and part of the primary factor endowments are attributed to the supply of some exogenous volume of energy.

The second core principle of KLEM is that it offers modellers the possibility to choose between different market specifications and macroeconomic closures, with a view to better capturing specific features of the modelled economy. As regards markets, KLEM allows choosing between perfect specifications, arguably more applicable to longer-term horizons, and imperfect specifications, which may be necessary to capture short-term constraints on economic growth. Additionally, KLEM offers the possibility to choose between different macroeconomic closures. Because economy-wide models must accommodate the basic national accounting constraint of balanced resources and uses (the pendant of the physicist's mass conservation principle), they would be overdetermined equation systems if they enforced behavioural specifications on all resources and uses. The "closure rule" is how models address this issue, with quantitative and qualitative consequences on their results (Ghersi et al., 2024).

Several KLEM applications exist on France and a set of emerging economies, published (on China by Su et al., 2022; on Saudi Arabia by Soummane et al., 2019) or at various stages of development (Algeria, Argentina, Brazil, France, Mexico, Nigeria, Senegal, South Africa, Tunisia, Serbia). The application of KLEM to Jamaica produced the KLEM-JAM model, which has for main traits a 'sticky price' specification of its aggregate labour market and a Johansen macroeconomic closure (see Ghersi et al., 2024). The online KLEM user guide provides the complete set of equations of the model.

## C. Coupling KLEM-JAM to OSeMOSYS

The coupling of KLEM-JAM to OSeMOSYS first required the aggregation of OSeMOSYS results into the format of energy system information necessary to KLEM-JAM. OSeMOSYS covers all energy system flows with high granularity, which allowed to compute the five aggregate energy flows that are necessary to KLEM: energy inputs into transformation, final energy consumptions by firms, final energy consumptions by households (approximated by residential and private car fuel flows), energy imports and energy exports. OSeMOSYS also covers both the investment and the operation and maintenance costs of energy supply systems, from which KLEM-JAM could infer the compared evolutions of the capital intensity versus labour & materials intensities of energy supply. However, OSeMOSYS does not model domestic energy market prices, although it draws international market prices from International Energy Agency (IEA) sources. Data collection allowed pinpointing prices for all domestic energy flows for the 2021 calibration year, which indeed contributed to setting up the original 'hybrid' IOT on which to calibrate KLEM-JAM (see Annex B). Assumptions of constancy for all price components not explicitly covered by OSeMOSYS allowed to project the 2021 market price data to 2050. Variations of that data therefore mainly reflect changes of the underlying energy mixes and propagation effects of the IEA international prices. Lastly but importantly, OSeMOSYS provides information on demand-side expenses, regarding (1) energy demand control programmes, (2) the acquisition of more efficient appliances, and (3) the specific efficiency of clinker production in the cement industry. Because these transition expenses correspond to current expenses on non-energy goods and services rather than to investment, KLEM took them into account, for the transition scenario (see below) as upward adjustments of the 'materials' intensities of non-energy production. All these computations were performed for both the BAU and LTS scenarios.

One second data collection and treatment effort from OSeMOSYS to KLEM-JAM regarded adaptation measures specific to the LTS scenario. The extensive coverage of such measures by OSeMOSYS resulted in the computation of 174 trajectories of 2021 USD flows, 104 of them costs, 70 of them benefits. Each of those flows were first assigned to one of 11 categories, then the categories mapped into 7 channels into KLEM including the productivity of factors, the GDP shares devoted to investment and public expenditure, and exports (Table 1).

Regretfully, the timeline of the study that brought OSeMOSYS and KLEM together on the analysis of the Jamaican economy and its low-carbon transition did not allow for the iterative running of both models to convergence put forward in the above Annex. The link was only established 'one-way' from OSeMOSYS to KLEM-JAM. To maximize consistency, though, the process of calibration of KLEM-JAM was extended to dynamic constraints to allow the model to replicate the GDP growth trajectory underlying OSeMOSYS projections for the Business-As-Usual (BAU) scenario.

**Table a1. Categorisation of OSeMOSYS adaptation flows and channelling into KLEM-JAM.**

| Adaptation flow category | Channel into KLEM-JAM |
|---|---|

| | |
|---|---|
| Consumption shift | No channel – the level of aggregation of KLEM does not allow to take account of consumption shifts for goods and services outside the energy sector. Concerns one benefit. |
| Investment | Investment rate – any investment flow is supposed to partially crowd-out general productivity investment (for 50 % of its amount) and partially build up the national investment rate (for the other 50%). The Johansen closure of KLEM-JAM translates the latter increase into a lower household consumption rate. |
| Labour productivity | Labour productivity in KLEM-JAM's non-energy sector. |
| Materials productivity | Materials productivity in KLEM-JAM's non-energy sector |
| Avoided medical cost | No channel – like consumption shifts, any reduction of medical costs is supposed to happen at the benefice of other expenses. The level of aggregation of KLEM dispenses to make any assumption on what expenses increase. Concerns three benefits. |
| Forest conservation | Natural resource and land rent – forest conservation bars access to land, thus increasing the rent from land occupation. |
| Outside KLEM scope | No channel – three time series of adaptation costs concern the building up and use of the National Disaster Fund and Livelihood Protection Policy. Corresponding benefits are capturing multiplier effects. The cost items resort to the secondary distribution of income, outside the scope of KLEM. The benefits are surmised macroeconomic effects, which KLEM endogenously computes. |
| Production shift | No channel – like consumption, production shifts escape the aggregate framework of KLEM. Concerns three benefits. |
| Public expenditure | Public consumption rate – any public expenditure flow is supposed to build up the national public consumption rate. The Johansen closure of KLEM-JAM translates this into a lower household consumption rate. |
| Total factor productivity | Capital, Labour and Material productivities in KLEM's non-energy production – any TFP effect is broken down into effects on the productivity of all primary and secondary factors excluding energy. |

| | |
|---|---|
| Tourism | Export shock – sales to non-residents amount to exports according to national accounting conventions. This is disregarding tourism activities by Jamaican nationals. |

### 3. I-O methodology

Using indicators from the KLEM-JAM model, annual estimates of aggregate GDP and labour force size are projected from 2024 to 2050. GDP forecasts follow the trajectory produced by KLEM-JAM, while labour force projections differ by scenario. In the Business-as-Usual (BAU) , labour force estimates align with trend-based population forecasts. Under the Long-Term Strategy (LTS) scenario, labour force projections incorporate the endogenous unemployment rate generated by the KLEM-JAM model, reflecting dynamic labour market adjustments within the LTS framework. This approach maintains consistency with macroeconomic modelling while accounting for sectoral structural changes.

To assess how these aggregate shifts translate into sector-specific impacts, an input-output (I-O) multiplier framework is applied using Jamaica's 2007 Supply-Use Tables, the most recent available dataset. This methodology enables the breakdown of aggregate GDP and employment changes into sectoral effects.

To analyse sector-specific economic and employment impacts arising from shifts in investment under both scenarios, we adopt the input-output methodology described in Hewings and Jensen (1987) and Miller and Blair (2009). This proportional weighting approach traces how final demand shocks propagate through the economy, ensuring that sectoral contributions align with total macroeconomic effects.

The analysis builds on Jamaica’s 2007 Supply and Use Table (SUT), which serves as the basis for constructing two key matrices: (1) a 12-sector matrix capturing direct and indirect effects across industries, and (2) an expanded 13-sector matrix to incorporate induced effects from household consumption. This structure supports a detailed sectoral disaggregation of economic and employment outcomes.

Several key economic variables, including wages, private consumption, employment levels, and components of final demand, are extracted from the SUT to construct the I-O matrices. The technical input coefficient matrix A is calculated as:

$$a_{ij} = \frac{x_{ij}}{x_j}$$

where $x_{ij}$ is the input from sector $i$ to sector $j$, and $x_j$ is total output of sector $j$. From this, the Leontief inverse matrix is derived as

$$L = (I - A)^{-1}$$

This matrix is used to generate output multipliers that quantify the economy-wide effects of changes in sectoral final demand.

Employment effects are estimated by calculating employment-output coefficients for each sector using:

$$e_i = \frac{E_i}{X_i}$$

where $E_i$ is employment and $X_i$ is output in sector i. These coefficients are then applied to the output multipliers to compute both Type I (direct and indirect) and Type II (including induced) employment multipliers.

To evaluate the dynamic impact of the climate transition, sectoral outputs under the LTS and BAU scenarios are compared. The cumulative impact is given by:

$$\Delta Y = Y_{LTS} - Y_{BAU}$$

where $Y_{LTS}$ and $Y_{BAU}$ denote sectoral outputs under the respective scenarios. These differentials are run through the I-O model to estimate cumulative economic and employment effects across sectors from 2024 to 2050. This method enables a detailed assessment of how the climate transition alters the structure and performance of Jamaica's economy at the sectoral level.

### 4. Fiscal Impact Modelling

Projections of fiscal indicators from 2024 to 2050 are developed using a framework adapted from the IMF (2021) Debt Sustainability Analysis (DSA) methodology, with references to Titelman et al. (2022, 2024). This approach allows for an integrated view of revenue, expenditure, and public debt dynamics across the BAU and LTS scenarios.

The government's fiscal position in each year t is determined by key budget components. Total revenue is defined as the sum of hydrocarbon and non-hydrocarbon revenues. In this analysis, hydrocarbon revenue is assumed to be zero, making total revenue fully dependent on non-hydrocarbon sources, projected as a share of GDP based on recent historical trends.

Expenditures are disaggregated into primary expenditure and interest expenses. Primary expenditure is further broken down into current and capital spending, with the latter including both general public investment and climate-specific investments in mitigation and adaptation. To maintain fiscal realism, capital investment trends are smoothed based on historical patterns. Recurrent spending and interest obligations are closely tracked as key fiscal sustainability indicators.

The fiscal balance is calculated as the difference between total revenue and total expenditure, while the primary balance excludes interest payments to focus on the underlying fiscal position. The debt stock evolves dynamically, with debt in year t equalling the previous year's debt adjusted by the fiscal balance. Interest expenses are calculated endogenously using the effective interest rate i, derived from historical averages as:

$$i = \frac{1}{2024 - t_0 + 1} \sum_{t=t_0}^{2024} i_t$$

with:

$$i_t = \frac{\text{interest expense}_t}{\text{debt}_{t-1}}$$

The full set of relationships governing fiscal projections is expressed as:

$$\text{revenue}_t = \text{non-hydrocarbon revenue}_t + \text{hydrocarbon revenue}_t$$

$$\text{expenditure}_t = \text{primary expenditure}_t + \text{interest expense}_t$$

$$\text{primary expenditure}_t = \text{current expenditure}_t + \text{capital expenditure}_t$$

$$\text{fiscal balance}_t = \text{revenue}_t - \text{expenditure}_t$$

$$\text{primary balance}_t = \text{revenue}_t - \text{primary expenditure}_t$$

$$\text{debt}_t = \text{debt}_{t-1} - \text{fiscal balance}_t \backslash$$

$$\text{interest expense}_t = \text{debt}_{t-1} \times i$$

1. In this projection framework, the fiscal balance, primary balance, debt stock, and interest expenses are modelled endogenously. Other variables, such as revenue and expenditure components, are treated as exogenous inputs based on historical data or policy assumptions. Total expenditure is determined numerically to ensure consistency with the historical average fiscal balance-to-GDP ratio, supporting long-term fiscal sustainability while incorporating increased climate-related investments. Appendix 6.5 describes the data sources sustaining this analysis.

# D. Data sources and scenario assumptions

## 1. Sectoral models: data sources

### a. Electricity sector

| Data | Source |
|---|---|
| Demographic and economic growth projections | For historical demographic statistics Statistical Institute of Jamaica (StatInJa, 2024)<br>For Economical projection World Economic Outlook 2025 (FMI, 2024) |
| Electric demand growth | 2018 Jamaica Integrated Resource Plan, Fig 22, Reference Case (MSET, 2020). |
| Installed capacity by technology [GW] | 2018 Jamaica Integrated Resource Plan Fig 64 y 65 (MSET, 2020), complemented with SieOLDADE reports (SieLAC-OLADE, 2022b). |
| Electric generation by technology [GWh] | An Overview of Jamaica's Electricity Sector form MSET(MSET, 2018a), complemented with SieOLDADE reports (SieLAC-OLADE, 2022a) |
| Investment costs [MUSD/GW], operational cost [MUSD/GWh] and operational life of power plants [years] | 2018 Jamaica Integrated Resource (MSET, 2020), complemented with NREL 2023 Annual Technology Baseline (NREL, 2023a).<br><br>Utility-Scale Battery Storage (NREL, 2024).<br><br>Cost Projections for Utility-Scale Battery Storage: 2023 Update (NREL, 2023b). |
| New planned capacity and retirements [GW] | 2018 Jamaica Integrated Resource, Table 3, Implementation Case and Appendix D (MSET, 2020). |
| Transmission and distribution Investment costs [MUSD/PJ] and operational costs [MUSD/PJ] | Annual Tariff Adjustment from JPS (JPS, 2015, 2022, 2023) |
| Transmission and distribution losses [%] | Estimated with SieOLDADE reports (SieLAC-OLADE, 2022a). |
| Energy consumption by sector and fuel [PJ] | National Energy Balances from MSET (MSET, 2023)<br><br>Economic and Social Survey Jamaica 2022 (PIOJ, 2022b). |
| Fuel prices [MUSD/PJ] | 2018 Jamaica Integrated Resource for Diesel, Fuel Oil and Natural Gas (MSET, 2020).<br><br>Petroleum Prices For Selected Products from MSET for Gasoline, LPG and Kerosene (MSET, 2018b).<br><br>World Energy Outlook for crude oil and coal (IEA, 2023).<br>Petroleum Coke Sample Report for pet coke (Argus Media, 2023). |

| Data | Source |
|---|---|
| Efficient appliances prices [USD/unit] | Prices are based on Energy Star-certified products (e.g., LED lighting, solar heaters, refrigerators) (Energy Star, s.f.) and electric stove costs from the World Bank (World Bank Group, 2020) |
| House materials prices [USD/house] | Traditional material costs from the Economic and Social Survey Jamaica (PIOJ, 2022b)<br>Low-carbon materials from "Building a More Resilient and Low Carbon Caribbean – Report 2." (Bailey et al., 2021) |
| Emission factors | Default values reported in the IPCC Guidelines, volume 2, chapter 2 Stationary Combustion (Intergovernmental Panel on Climate Change, 2006) |

### b. Transport sector

| Data | Source |
| --- | --- |
| Fleet composition in the reference year (2017) and importation data to estimate the fleet composition in the calibration year (2021). | Strategic Framework for Electric Mobility (Inter American Development Bank, 2022). Importation data from IRF World Road Statistics Datawarehouse (International Road Federation, 2024). |
| Transport technologies efficiency. | Strategic Framework for Electric Mobility (Inter American Development Bank, 2022). |
| Travelled distance per technology. | Adapted from the "Plan Estratégico Nacional de Movilidad Eléctrica de República Dominicana" (INTRANT, 2020). |
| Percentage of fuel consumption per technology. | Developing Jamaica's long-term strategy for low emission and climate resilient development (Vivid Economics and the World Bank, 2021);<br><br>Jamaica's long-term climate change strategy recommendations (Vivid Economics and the World Bank, 2021). |
| Relation between the number of public charging stations and electric vehicles. | Emerging best practices for electric vehicle charging infrastructure (Hall, D & Lutsey, N, 2017).<br><br>Nota técnica N1, Movilidad eléctrica en América Latina y el Caribe - Monitoreando la electromovilidad (OLADE, 2024). |
| Costs. | Strategic Framework for Electric Mobility (Inter American Development Bank, 2022). |
| Local health externalities. | Global Fossil Fuel Subsidies Remain Large: An Update Based on Country Level Estimate del International Monetary Fund (IMF) (Coady et al., 2019). |
| Transport emission factors. | Default values reported in the IPCC Guidelines, volume 2, chapter 2 Stationary Combustion (Intergovernmental Panel on Climate Change, 2006, p. 2). |

### c. Industrial sector

| Data | Source |
|---|---|
| Energy consumption by industry and fuel [PJ] | National Energy Balances from MSET (MSET, 2023) and Economic and Social Survey Jamaica 2022 (PIOJ, 2022b). |
| Fuel prices [MUSD/PJ] | 2018 Jamaica Integrated Resource for Diesel, Fuel Oil and Natural Gas (MSET, 2020) .<br><br>Petroleum Prices For Selected Products from MSET for Gasoline, LPG and Kerosene (MSET, 2018b).<br><br>World Energy Outlook for crude oil and coal (IEA, 2023).<br>Petroleum Coke Sample Report for pet coke (Argus Media, 2023). |
| Emission factors | Default values reported in the IPCC Guidelines, volume 2, chapter 2 Stationary Combustion (Intergovernmental Panel on Climate Change, 2006) |
| Cement production and Clinker-to-cement ratio | Developing Jamaica's long-term strategy for low emission and climate resilient development (Vivid Economics & World Bank Group, 2021a).<br><br>Jamaica's long-term climate change strategy recommendations (Vivid Economics & World Bank Group, 2021b). |
| Emission factor of Clinker production | $CO_2$ emissions from Cement Production (IPCC, 2019). |
| Investment, fixed and variable costs of clinker/cement production | Techno-economic analysis of calcium looping processes for low $CO_2$ emission cement plants (De Lena et al., 2019). |
| Additional costs of reduce Clinker-to-cement ratio | Cost-Efficient Decarbonization of Portland Cement Production (Glenk et al., 2023). |
| HFCs consumption, lime production, emissions from lubricant oxidation | Developing Jamaica's long-term strategy for low emission and climate resilient development (Vivid Economics & World Bank Group, 2021a).<br><br>Jamaica's long-term climate change strategy recommendations (Vivid Economics & World Bank Group, 2021b). |
| Costs of energy efficiency programs in industry | Jamaica's Climate Action Enhancement Package (CAEP) Programme Synthesis Report (MEGJC, 2022). |

### d. Waste sector

| Data | Source |
| --- | --- |
| Solid waste generation | Economic and Social Survey Jamaica 2015-2022 (PIOJ, 2022a). |
| Wastewater generation | Economic and Social Survey Jamaica 2015-2022 (PIOJ, 2022a). |
| Solid waste treatment and disposal profile | What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050 (Kaza et al., 2018). |
| Wastewater treatment and disposal profile | Jamaica’s Climate Change Research Agenda 2020-2030 (Lanza et al., 2022).<br><br>Wastewater Management in the Caribbean: A Jamaican Case Study (Mandal & Parker, 2023). |
| Emissions | Developing Jamaica’s long-term strategy for low emission and climate resilient development (Vivid Economics & World Bank Group, 2021a).<br><br>Jamaica’s long-term climate change strategy recommendations (Vivid Economics & World Bank Group, 2021b). |
| Technological costs | Sostenibilidad financiera de la gestión de residuos sólidos en América Latina y el Caribe (Correal, Faleiro, et al., 2023). Inter-American Development Bank.<br><br>Adapted from “Elaboración de los estudios y diseños a nivel de prefactibilidad de la primera fase de un programa de saneamiento ambiental en la cuenca norte del área metropolitana de la ciudad de Guatemala”. Inter-American Development Bank. |
| Externalities: water source contamination costs, care of waste-related diseases, income from circular economy (sale of treated water and compost). | Lineamientos sectoriales para la gestión de residuos sólidos y el avance hacia la economía circular (Correal, Rihm, et al., 2023). Inter-American Development Bank.<br><br>El reúso de agua residual tratada en América Latina y el Caribe: 10 estudios de caso (De la Peña et al., 2022). Inter-American Development Bank.<br><br>Gestión Integral de Residuos Sólidos de la Mancomunidad Nororiente (BID, 2023). Inter-American Development Bank. |
| Cost ratio of preliminary and tertiary wastewater treatment | Comparative evaluation of cost for preliminary and tertiary municipal wastewater treatment plants in Istanbul (Ozgun et al., 2021). |

## e. Food Security sector.

| Data point description | Value [USD] | Source |
|---|---|---|
| Agroforestry systems with hedgerows - Installation Labor cost.<br>cropland is 31,3% of the total country land. Total country land is 1 090 000 ha. Cropland of Jamaica. = 341 000 ha.<br>10% of the total cropland of Jamaica. = 34100 ha. Divided in 25 years = 1364 ha/ year | 293 /ha/year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Agroforestry systems with hedgerows - Maintenance Labor cost.<br>17732 ha/ year is the annual mean of the total amount of ha that will implement agroforestry from 2025 to 2050. | 58,8 /ha /year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Contour ditches - Installation Labor cost.<br>Jamaica's topography: 384 000 ha with slopes less than 10º. Contour farming is successful with that condition. As a third part of the country is cropland, we assume a third part of that topography has crops. And, we assume 10% of that area will implement contour = 11 366 ha. And divided in 25 years = 455 ha/year | 350,7 /ha /year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Contour ditches - Maintenance Labor cost<br>5919 ha/ year is the annual mean of the total amount of ha that will implement contour from 2025 to 2050 | 58,8 /ha /year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Value of soil loss avoided by implementing contour ditches.<br>Soil erosion in Jamaica is 133 t/year/ha.<br>Contour reduces 50% erosion | 0,008 / t | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |

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| So the erosion avoided is 66,5 t/ha/year, multiplied by 5919 (annual mean that implemented contour during 2025-2050) = 393347,5 ton/year and multiplied by 0.008 | | Madramootoo, C. A. (2000). An integrated approach to land and water resources management in the Caribbean. En Land Resources Information Systems in the Caribbean. FAO. https://www.fao.org/4/y1717e/y1717e21.htm Jamaica Information Service. (2020, 7 de enero). *Get the facts – Climate-smart farming practices*. https://jis.gov.jm/information/get-the-facts/get-the-facts-climate-smart-farming-practices/ |
| Value of agroforestry systems with hegderows | 7,35 / ha/year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Crop rotation (maize/bean) Labor cost.<br>Maize + Beans production area in Jamaica is 2305 ha/year.<br>We assume that 30% of the total area of maize+beans production will implement crop rotation = 691,5 ha. Divided in 25 years= 28 ha/years. The calculated mean of ha with crop rotation implementation between 2025-2050 is 364 | 1951 /ha/year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004<br><br>Ministry of Agriculture, Jamaica. (2023). All-Island estimates of crop area reaped: 2014–2023 (PDF). https://www.moa.gov.jm/sites/default/files/Area_reaped_10yrs_2014-2023.pdf |
| Biodiversity benefits for implementing climate-smart agriculture on 10% of the total cropland in Jamaica, the mean of 17732 ha/year | 11,5 /ha /year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Value of firewood obtained from agroforestry at the end of life cycle 45.5 USD/bunch, and assuming 1 bunch of firewood per tree, 60 bunches per hectare.<br>And 1 harvest in the 25 years period. So 60*45.5 =2730 usd/ha | 2730 / ha | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Value of conservation tillage with mulch. | 1,092 / ha | |

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| Assuming half of the area that will implement agroforestry (5% of the total cropland) and annual crops, will implement conservation tillage, 17050 ha by 2050<br>17050/25= 682 ha/year<br>The mean in 25 years of implementation is 8525 ha/year. | | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Value of soil loss avoided by implementing conservation tillage. 0.008 USD/ t<br>Soil erosion in Jamaica is 133 t/year/ha and it will be avoided by conservation tillage. 133*8525=<br>1 133 825 t / year | 0.008 | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Increases in production yields for implementing climate-smart agriculture. 30 % increase in crops yield, will bring 30% more profits. 57 042 000 USD (TOTAL VALUE agricultural exports 2023), the 10% area that will implement smart agriculture will generate 5 704 200 USD and the 30% increase of that would be 1 711 260 USD/year more. 20 103 ton/ year were exported and the 10% 2010 ton and a 30% increased of that is 603 t. 1711260/603= 2837 USD/ton | 2837 / t | International Trade Centre. (2025). *Trade Map: International trade statistics by country and product* [Base de datos]. https://www.trademap.org/Product_SelCountry_TS.aspx?nvpm=%7c188%7c%7c%7c%7cTOTAL%7c%7c%7c2%7c1%7c1%7c1%7c2%7c1%7c1%7c1%7c%7c1 |
| Pest and disease-tolerant varieties implementation Labor cost. We assume 5% of the total cropland in Jamaica will implement pest and disease-tolerant varieties and we assume the same costs for all crops.<br>17 050 ha. Divided in 25 years = 682 ha/ year | 334 / ha | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Benefit for the reduction in the use of pesticides for the implementation of pest | 7,5 / ha | |

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| and disease-tolerant varieties.<br>6,1 USD / ha (2017) so in terms of 2024= 7,5 usd/ha | | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Heat and stress-tolerant varieties implementation Labor cost. We assume 5% of the total cropland in Jamaica will implement pest and disease-tolerant varieties and we assume the same costs for all crops.<br>17 050 ha. Divided in 25 years = 682 ha/ year | 334 / ha | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Implementing drip irrigation Installation and purchase.<br>The mean is 1400 usd/acre. Converted to ha is 3500 usd/ha.<br>Target is to increase by 20% irrigation. Percentage of agricultural land that is irrigated in Jamaica is 7.3% = = 24 893 ha. A 20% of 24 893 ha = 4978,6 ha. 4978,6/25 = 199 ha / year. And half of that is drip and the other sprinkler | 3500 /ha | World Bank. (s. f.). *Agricultural irrigated land (% of total agricultural land) — Jamaica (AG.LND.IRIG.AG.ZS)*. The World Bank. https://data.worldbank.org/indicator/AG.LND.IRIG.AG.ZS?locations=JM<br><br>Ministry of Agriculture and Fisheries. (2021). Drip irrigation systems fed by rainwater harvesting: Technology description. Government of Jamaica; UNEP DTU Partnership. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/02/agriculture-sector-policy-brief-jamaica.pdf<br><br>MOAF-1st-quarter-finalrevised1.pdf<br>Ministry of Agriculture and Fisheries. (2021). *Quarterly performance review report: April–June 2021* (First quarter performance report). Government of Jamaica. https://www.moa.gov.jm/sites/default/files/pdfs/MOAF-1st-quarter-finalrevised1.pdf |
| Implementing sprinkler irrigation Installation and purchase.<br>The mean is 1100 usd/acre. Converted to ha is 2750 usd/ha.<br>Target is to increase by 20% irrigation. Percentage of agricultural land that is irrigated in Jamaica is 7.3% = = 24 893 ha. A 20% of 24 893 ha = 4978,6 ha. 4978,6/25 = 199 ha / year. And half of that is drip and the other sprinkler | 2750 / ha | Ministry of Agriculture and Fisheries. (2021). Drip irrigation systems fed by rainwater harvesting: Technology description. Government of Jamaica; UNEP DTU Partnership. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/02/agriculture-sector-policy-brief-jamaica.pdf |

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| Drip irrigation and sprinkler irrigation Maintenance Labor cost. And the calculated mean is 2587 ha / year for the ha's that will implement irrigation in these years | 111 / ha /year | Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004 |
| Increases in production yields for implementing smart irrigation. (20%)<br>57 042 000 USD (total value agricultural exports 2023) in Cropland of Jamaica. = 341 000 ha = 167 usd / ha<br>Target is to increase by 20% irrigation. Percentage of agricultural land that is irrigated in Jamaica is 7.3%= 24 893 ha. A 20% of 24 893 ha = 4978,6 ha./ 25 = 199 ha / year. And the calculated mean between 2026 -2050 is 2587 ha /year that will implement irrigation | 167 / ha | Jamaica Information Service. (2022, 25 de mayo). Innovative young farmer engineers smart irrigation system. https://jis.gov.jm/features/innovative-young-farmer-engineers-smart-irrigation-system/<br><br>Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. Agricultural Systems, 151, 163–173. https://doi.org/10.1016/j.agsy.2016.05.004<br><br>Food and Agriculture Organization of the United Nations. (s. f.). *Global maps of irrigated areas: Irrigation by country — Jamaica*. FAO AQUASTAT. fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/irrigation-by-country/country/JAM/index.html<br><br>Forestry Department, Jamaica. (2020). Assessment of land use change and drivers of deforestation and degradation (Deliverable 11). Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/Deliverable_11_-_Assessment_of_land_use_change_and_drivers_of_deforestation_and_degradation.pdf |
| Cassava root meal as substitute for maize in animal feed.<br>We assume a 30% of the total amount of maize that is used as animal feed goes from maize to cassava.<br>The maize production is 2 400 000 kg /year.<br>The 56% of that is 1 344 000 kg/year.<br>The 30% of that is 403200 kg/year | 0,1 / kg | Anaeto, M., & Adighibe, L. C. (2011). *Cassava root meal as substitute for maize in layers ration*. *Brazilian Journal of Poultry Science, 13*(2). https://doi.org/10.1590/S1516-635X2011000200010<br><br>Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. M. (2022). *Global maize production, consumption and trade: Trends and R&D implications*. *Food Security, 14*(5), 1295–1319. https://doi.org/10.1007/s12571-022-01288-7<br><br>Tridge. (s. f.). *Corn production — Jamaica*. https://www.tridge.com/intelligences/corn/JM/production |

## f. Terrestrial Ecosystems sector

| Data point description | Value [USD] | Source |
|---|---|---|
| The nursery program implemented and expanded. Budget= 312 178 000 J$ / 5 years. Divided into 5 and converted to us dollars to obtain USD/year | 393 171 / year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Nursery revenue generated was 12.2 J$ million / year. Converted to US dollars | 76 826 / year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Reforestation costs were 747 163 000 J$ / 4120 ha. Divided into 4120 and converted to us dollars to obtain USD/ha | 1142 /ha | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Improve and develop Forest Management Plans (FMP) was 1 594 006 000 + 147 711 000 J$ / 5 years implementation. Divided into 5 and converted to us dollars to obtain USD/year | 2 194 033 / year / plan | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Management practices for riparian forests and implementation was 51 499 000 J$ / 80% implementation. Converted to us dollars and to 20% implementation (amount missing) = 81 074 usd. Divided into 3 years. | 27 025 / year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Training course Silviculture. 59 347 000 J$/ 6 Forestry Department staff & officer. Divided into 6 = 9 891 166 J$/ one Forestry Department staff & officer. Divided into 2 = 4 945 583 J$ / one department staff. Converted to us dollars | 31 143 / one department staff | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Improved availability of spatial data for sustainable | 63 246 /species data/ year | |

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| forest management was 401 747 000 J$ / 8 species data / 5 years. Divided in 8 and then in 5 and converted to us dollars | | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Weather station AWS Davis Vantage Pro 2 | 824.52 / weather station | Davis Instruments. (2025). *Davis Instruments Wireless Vantage Pro2 Weather Station with WeatherLink Console* [Product]. Amazon. https://www.amazon.com/Davis-Instruments-Wireless-Vantage-WeatherLink/dp/B0BZT3RFLG |
| Permanent Sampling Plots (PSPs) 181 111 000 J$ / 200 plots established and converted to us dollars | 5702 / plot stablished | *Forestry Department, Jamaica. (2021). National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan). Government of Jamaica.* https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Costs of conservation. 2 264 000 USD/187 620 ha / year in 2000. Divided into 187 620 and converted to 2024 US dollars. | 32 /ha/year | Cesar, H. S. J., Ohman, M., Espeut, P., & Honkanen, M. L. (2000). Economic valuation of an integrated terrestrial and marine protected area: Jamaica's Portland Bight. En H. S. J. Cesar (Ed.), Collected essays on the economics of coral reefs (pp. 203–214). CORDIO, Kalmar University. https://www.researchgate.net/publication/236628219_Economic_valuation_of_an_integrated_terrestrial_and_marine_protected_area_Jamaica's_Portland_Bight |
| Soil covered with mulch can reduce erosion. 91,1 t/Mz/year converted to ha = 130 t/ha/year.<br>Value of soil loss by erosion 0.008 USD/t. Multiplied for 3900 ha the first years and then 4200 the other years (ha reforested) | 0.008 / t | Idem |
| Silvopastures reduce heat stress losses in livestock. Economic losses are approx. 2 billion USD/ year in the USA. There are 87 million livestock units in USA. In Jamaica there are 183 632 units. Jamaica's livestock represents 0.2% of USA livestock. So, economic losses in Jamaica would be 4 MUSD/year. | 13 /ha / year | Poudel, S., Pent, G., & Fike, J. (2024). Silvopastures: Benefits, past efforts, challenges, and future prospects in the United States. Agronomy, 14(7), 1369. https://doi.org/10.3390/agronomy14071369<br><br>Statista. (s. f.). Total number of cattle and calves in the U.S. since 2001 (Statista Statistics No. 194297). https://www.statista.com/statistics/194297/total-number-of-cattle-and-calves-in-the-us-since-2001/ |

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| 4MUSD/ 305 000 ha of pastures in Jamaica= 13 USD/ha/year | | |
| Livestock in Jamaica 183 632 units. Livestock in USA 87 million units. The number of Jamaican livestock represents 0,2% of USA livestock. The pastures area in Jamaica is 305 000 ha.<br>0,2% of 2 000 000 000 USD = 4 MUSD/year<br>4 000 000 USD/ 305 000 ha= 13 USD | 13 / year / ha | Ministry of Agriculture, Jamaica. (2023). *Livestock statistics 2023*. Government of Jamaica. https://www.moa.gov.jm/sites/default/files/livestock_statistics_2023.pdf<br><br>Total number of cattle and calves in the U.S. 2024 \| Statista<br>Statista. (s. f.). *Total number of cattle and calves in the U.S. since 2001* (Statista Statistics No. 194297). https://www.statista.com/statistics/194297/total-number-of-cattle-and-calves-in-the-us-since-2001/ |
| Value obtained from charcoal production from forests. 100000 USD / year / 21 000 ha. Divided into 21 000. | 13 / year / ha | Cesar, H. S. J., Ohman, M., Espeut, P., & Honkanen, M. L. (2000). *Economic valuation of an integrated terrestrial and marine protected area: Jamaica's Portland Bight*. En H. S. J. Cesar (Ed.), *Collected essays on the economics of coral reefs* (pp. 203–214). CORDIO, Kalmar University. https://www.researchgate.net/publication/236628219_Economic_valuation_of_an_integrated_terrestrial_and_marine_protected_area_Jamaica's_Portland_Bight |
| Value of tourism and recreation for reforested areas. Assuming 10% of what is being reforested will attract tourism= 10% of 3900 ha annually= 390 ha (first years)<br>10% of 4200 ha annually= 420 ha (later years). Value is 75USD /year /ha (year 2000), and converted to 2024 | 202 / year / ha | Idem |
| Value of coastal conservation by mangroves 400000 USD / year / 21 000 ha. Divided in 21 000 = 19 USD / year / ha (year 2000), and converted to 2024 | 51 / year / ha | Idem |
| Implement a cross-sectoral mechanism for integrating the Forest Sector into relevant national decision-making processes. 38 700 000 J$/ 5 years. Divided into 5 and converted to US dollars | 48 740 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |

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| Amend the Forest Act and its regulations 37 510 000 J$/ 5 years. Divided into 5 and converted to US dollars | 47 241 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Development Orders prepared and updated regarding forest management priorities. 59 250 000 J$/ 5 years. Divided in 5 and converted to US dollars | 74 622 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Transfer by the Commissioner of Lands, crown lands to the Forestry Department 67316000 J$/ 5 years. Divided into 5 and converted to US dollars | 84 780 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Support the strengthening of the approaches governing issues of tenure and trespass on forest estates. 180 111 000 J$/ 5 years. Divided into 5 and converted to US dollars | 226 838 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Develop regulations that permit and license activities such as: special recreational use, research, lease program and permit the use of performance bonds 34 970 000 J$/ 5 years. Divided into 5 and converted to US dollars | 44 042 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Expand and accelerate the boundary verification program for forest estates 552 865 000 J$/ 5 years / 7 parcels. Divided in 5 and then in 7 and converted to US dollars. | 99471 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Develop and maintain a list of invasive plant and animal species in forested areas and design and set up a working group to implement a plan for control of these species. 131 810 000 J$/ 5 years. | 166 007 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |

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| Divided in 5 and converted to US dollars | | |
| Develop initial (pilot) species conservation plans and survey and map the distribution of targeted species 69 400 000 J$/ 5 years. Divided in 5 and converted to US dollars | 87 405 / process /year | Forestry Department, Jamaica. (2021). *National Forest Management and Conservation Plan (NFMCP) 2021–2026: Monitoring, evaluation & reporting plan (PMER Plan)*. Government of Jamaica. https://www.forestry.gov.jm/resourcedocs/NFMCP_PMER_Plan_2021-2026-Final.pdf |
| Biodiversity value generated by forests. We assume half of what is going to be reforested will produce a biodiversity value.<br>The mean of forest reforestation that will happen between 2025-2050 is 3900 ha/ year the first years. 4200 ha/years the other years and 2080 ha/ year the mangroves. So, half of that is 1950, 2100 and 1040 ha/ year.<br>The value was 10000 USD/km2 in the year 2000. So converted to ha and 2024 is 269,4 | 269,4 /ha/year | M. L. (2000). *Economic valuation of an integrated terrestrial and marine protected area: Jamaica's Portland Bight*. En H. S. J. Cesar (Ed.), *Collected essays on the economics of coral reefs* (pp. 203–214). CORDIO, Kalmar University. https://www.researchgate.net/publication/236628219_Economic_valuation_of_an_integrated_terrestrial_and_marine_protected_area_Jamaica's_Portland_Bight |
| Visual amenity services, cultural services: Spiritual, artistic and symbolic services, species appreciation. The value is 11.35 USD/ha in the year 2000 so converted to 2024= 16,4 USD/ha.<br>The mean of forest reforestation that will happen between 2025-2050 is 3900 ha/ year the first years. 4200 ha/years the other years and 2080 ha/ year the mangroves. We assume 20% of what will be reforested will produce this value. A 20% of 3900 ha/year = 780 ha /year. 20% of 4200 ha/year = 840 ha/year. 20% of 2080 = 416 ha/year | 16,4/ha/year | Curtis, I. A. (2004). *Valuing ecosystem goods and services: A new approach*. *Ecological Economics, 50*(3–4), 163–194. https://doi.org/10.1016/j.ecolecon.2004.02.003 |
| Air regulation from forests. The mean of forest reforestation that will happen between 2025-2050 is 3900 ha/ year the first years. 4200 ha/years the other years and 2080 ha/ year the mangroves. | 4687 / ha/ year | Stults, S. (2018). A spatial analysis of northern Guatemala (master's Thesis, The Ohio State University). https://docslib.org/doc/9371168/a-spatial-analysis-of-northern-guatemala |

## g. Human settlements and critical infrastructure

| Data point description | Value [unit] | Source |
|---|---|---|
| Cost of a two -bedroom concrete house | 60,000 [US$/housing unit] | Inter-American Development Bank. (2021). *The state of social housing in six Caribbean countries*. https://webimages.iadb.org/publications/english/document/The-State-of-Social-Housing-in-Six-Caribbean-Countries.pdf<br>Jamaica Information Service. (May, 2023). *Get the facts — The Indigent Housing Programme*. https://jis.gov.jm/information/get-the-facts/get-the-facts-the-indigent-housing-programme/<br><br>Local Government Jamaica. (July, 2024). *Two indigent houses handed over in Manchester*. https://www.localgovjamaica.gov.jm/two-indigent-houses-handed-over-in-manchester/ |
| Cost of an AC unit for small bedroom (with installation) | 774 [US$/unit] | ENERGY STAR. (s. f.). *Product Finder*. https://www.energystar.gov/productfinder/<br><br>Midea. (2025). *8,000 BTU 115-Volt U-Plus Shaped Smart Inverter Window Air Conditioner with Wi-Fi for up to 350 sq ft, ENERGY STAR® (Model MAW08U1QWT)* [Producto]. The Home Depot. https://www.homedepot.com/p/Midea-8-000-BTU-115-Volt-U-Plus-Shaped-Smart-Inverter-Window-Air-Conditioner-Wi-Fi-for-up-to-350-sq-ft-Energy-Star-2024-MAW08U1QWT/327511952<br><br>Easyship. (s. f.). *Duties and taxes calculator — Jamaica*. https://www.easyship.com/duties-and-taxes-calculator/jamaica |
| Residential electricity cost | 0.45 [US$/kWh] | United for Efficiency. (2020). *JAM U4E country saving assessment: Cooling* (United for Efficiency report). https://united4efficiency.org/wp-content/uploads/2020/11/JAM_U4E-Country-Saving-Assessment_Cooling_Oct-20.pdf |

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| | | Oppong, F. B., Hibbert, K., & Gonzalez-Cruz, J. (2024). *Extreme heat in the Caribbean: Impacts on wellbeing and buildings energy infrastructure — The 2023 summer case*. *ASME Journal of Engineering for Sustainable Buildings and Cities, 5*(3), 031007. https://doi.org/10.1115/1.4066382 |
| Cost of performing CCVRA at a community level | 34,000 [US$/community] | ICLEI USA. (2023). *Fee-based services: Climate change adaptation and community resilience* (August 2023). https://icleiusa.org/wp-content/uploads/2023/08/August-2023-Fee-Based-Services-Climate-Change-Adaptation-and-Community-Resilience.pdf<br>Statistical Institute of Jamaica. (2012). Population and Housing Census 2011: Jamaica—General Report (Volume I). Statistical Institute of Jamaica. https://census.statinja.gov.jm/wp-content/themes/futurio-child/Census2011Reports/Population%20and%20Housing%20Census%202011%20Jamaica%20General%20Report%20Vol%201.pdf |
| Construction cost of artificial wetland (CW) | 150,000 [US$/ha] | Japan International Cooperation Agency (JICA). (s. f.). Project completion report.https://openjicareport.jica.go.jp/pdf/1000041062_24.pdf<br>Snyder, B. F. (2019). *The inclusion of ecosystem service valuations in bioenergy cost analysis: A case study of constructed wetlands in the Neotropics*. *Ecological Economics, 156*, 196–201. https://doi.org/10.1016/j.ecolecon.2018.10.005<br>Crisman, T. L., & Winters, Z. S. (2023). *Caribbean small island developing states must incorporate water quality and quantity in adaptive management of the water-energy-food nexus*. *Frontiers in Environmental Science, 11*, 1212552. https://doi.org/10.3389/fenvs.2023.1212552 |
| Annual O&M cost of artificial wetland (WC) | 7,500 [US$/ha] | Japan International Cooperation Agency (JICA). (s. f.). Project completion |

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| | | report.https://openjicareport.jica.go.jp/pdf/1000041062_24.pdf<br>Snyder, B. F. (2019). *The inclusion of ecosystem service valuations in bioenergy cost analysis: A case study of constructed wetlands in the Neotropics*. *Ecological Economics, 156*, 196–201. https://doi.org/10.1016/j.ecolecon.2018.10.005<br>Crisman, T. L., & Winters, Z. S. (2023). *Caribbean small island developing states must incorporate water quality and quantity in adaptive management of the water-energy-food nexus*. *Frontiers in Environmental Science, 11*, 1212552. https://doi.org/10.3389/fenvs.2023.1212552 |
| Benefit: Ecosystem service valuation – wastewater treatment | 2,603 [US$/ha] | Brander, L. M., de Groot, R., Schägner, J. P., Guisado-Goñi, V., van 't Hoff, V., Solomonides, S., McVittie, A., Eppink, F., Sposato, M., Do, L., Ghermandi, A., Sinclair, M., & Thomas, R. (2024). Economic values for ecosystem services: A global synthesis and way forward. Ecosystem Services, 66, Article 101606. https://doi.org/10.1016/j.ecoser.2024.101606 |
| Benefit: Ecosystem service valuation – wastewater treatment | 4,969 [US$/ha] | Brander, L. M., de Groot, R., Schägner, J. P., Guisado-Goñi, V., van 't Hoff, V., Solomonides, S., McVittie, A., Eppink, F., Sposato, M., Do, L., Ghermandi, A., Sinclair, M., & Thomas, R. (2024). Economic values for ecosystem services: A global synthesis and way forward. Ecosystem Services, 66, Article 101606. https://doi.org/10.1016/j.ecoser.2024.101606 |
| Benefit: Ecosystem service valuation – wastewater treatment | 493 [US$/ha] | Brander, L. M., de Groot, R., Schägner, J. P., Guisado-Goñi, V., van 't Hoff, V., Solomonides, S., McVittie, A., Eppink, F., Sposato, M., Do, L., Ghermandi, A., Sinclair, M., & Thomas, R. (2024). Economic values for ecosystem services: A global synthesis and way forward. Ecosystem Services, 66, Article 101606. https://doi.org/10.1016/j.ecoser.2024.101606 |
| The cost of installing new water pipelines to the distribution network | 112,291[US$/km] | National Water Commission Jamaica. (2024). *Updated news release — Viewing of pipelines* (Actualizado 28 de agosto de 2024). https://nwcjamaica.com/Articles/4-20240830-Updated%20News%20Release%20-%20Viewing%20of%20pipelines%20August%2028%202024-%20rev.pdf |

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| | | Jamaica Information Service. (2024, 22 de julio). *$1.5B earmarked for NWC's installation of 35,000 water meters this year*. https://jis.gov.jm/1-5b-earmarked-for-nwcs-installation-of-35000-water-meters-this-year/ Office of Utilities Regulation, Jamaica. (2016). *National Water Commission mid-tariff review 2016* (Final Report). https://our.org.jm/wp-content/uploads/2021/04/nwc_mid_tariff_review_1_-_august__2016r3_3.pdf |
| The cost of O&M of water distribution network | 1974 [US$/km] | National Water Commission, Jamaica. (2018). *Tariff submission 2018*. National Water Commission. https://www.nwcjamaica.com/uploads/document/NWC%20Tariff%20Submission%202018.pdf |
| The cost of retrofitting water distribution pipelines | 24,704 [US$/km] | Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). *Lifelines: The resilient infrastructure opportunity* (Sustainable Infrastructure Series). World Bank. https://doi.org/10.1596/978-1-4648-1430-3 National Water Commission Jamaica. (2024). *Updated news release — Viewing of pipelines*. https://nwcjamaica.com/Articles/4-20240830-Updated%20News%20Release%20-%20Viewing%20of%20pipelines%20August%2028%202024-%20rev.pdf Jamaica Information Service. (2024). *$1.5B earmarked for NWC's installation of 35,000 water meters this year.* https://jis.gov.jm/1-5b-earmarked-for-nwcs-installation-of-35000-water-meters-this-year/ Office of Utilities Regulation, Jamaica. (2016). *National Water Commission mid-tariff review 2016* (Final Report). https://our.org.jm/wp-content/uploads/2021/04/nwc_mid_tariff_review_1_-_august__2016r3_3.pdf Office of Utilities Regulation, Jamaica. (2016). *National Water Commission mid-tariff review 2016* (Final Report). https://our.org.jm/wp-content/uploads/2021/04/nwc_mid_tariff_review_1_-_august__2016r3_3.pdf |
| The cost of retrofitting WWTP | 0.007 [US$/m3] | Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). *Lifelines: The resilient infrastructure opportunity* (Sustainable Infrastructure Series). |

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| | | World Bank. https://doi.org/10.1596/978-1-4648-1430-3<br>Office of Utilities Regulation, Jamaica. (2016). *National Water Commission mid-tariff review 2016* (Final Report). https://our.org.jm/wp-content/uploads/2021/04/nwc_mid_tariff_review_1_-_august__2016r3_3.pdf |
| The cost of retrofitting sewerage pipelines | 0.03 [US$/m3] | Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). *Lifelines: The resilient infrastructure opportunity* (Sustainable Infrastructure Series). World Bank. https://doi.org/10.1596/978-1-4648-1430-3<br>Office of Utilities Regulation, Jamaica. (2016). *National Water Commission mid-tariff review 2016* (Final Report). https://our.org.jm/wp-content/uploads/2021/04/nwc_mid_tariff_review_1_-_august__2016r3_3.pdf |
| The cost of community sized RWHS (buying and installing) | 50,0000 [US$/system] | TNA Jamaica<br>TNA Policy Brief<br>United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Technology Action Plan Jamaica: Accelerating climate technology deployment for adaptation and mitigation*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/04/tap-report-jamaica.pdf<br>United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Water resources policy brief: Jamaica*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/02/water-resources-policy-brief-jamaica.pdf |
| The cost of capacity building for RWHS | 3000 [US$/new system] | United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Technology Action Plan Jamaica: Accelerating climate technology deployment for adaptation and mitigation*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/04/tap-report-jamaica.pdf<br>United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Water resources policy brief: Jamaica*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/02/water-resources-policy-brief-jamaica.pdf |

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| Annual O&M of RWHS | 2000 [US$/ system] | United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Technology Action Plan Jamaica: Accelerating climate technology deployment for adaptation and mitigation*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/04/tap-report-jamaica.pdf United Nations Environment Programme Climate Change Centre (UNEP-CCC). (2022). *Water resources policy brief: Jamaica*. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2022/02/water-resources-policy-brief-jamaica.pdf |
| The cost of the NRW reduction program | 11.52 [US$/MCM] | National Water Commission Jamaica. (s. f.). *Water services and projects*. https://www.nwcjamaica.com/project1.php Statistical Institute of Jamaica. (2012). *Population and housing census 2011: Jamaica — General report (Vol. I)*. Statistical Institute of Jamaica. https://census.statinja.gov.jm/wp-content/themes/futurio-child/Census2011Reports/Population%20and%20Housing%20Census%202011%20Jamaica%20General%20Report%20Vol%201.pdf |
| Benefit - – counterfactual: Avoided production costs of water | 26.7 [US$/MCM] | National Water Commission, Jamaica. (2018). *Tariff submission 2018*. National Water Commission. https://www.nwcjamaica.com/uploads/document/NWC%20Tariff%20Submission%202018.pdf National Water Commission. (2019). *Annual report 2019*. National Water Commission. https://nwcjamaica.com/uploads/document/annual%20reports/NWC%20Report%202019%20.pdf |
| The cost of retrofitting transport infrastructure (roads, bridges, highways) | 31,800 [US$/km] | Planning Institute of Jamaica. (s. f.). *Damage and loss assessments — 2008 PIOJ report: Storm Gustav*. https://www.pioj.gov.jm/product/damage-and-loss-assessments-2008-pioj-report-storm-gustav/ National Works Agency, Jamaica. (s. f.). *Major infrastructure development programme*. https://www.nwa.gov.jm/major-infrastructure-development-programme |
| Benefit – counterfactual: Avoided loss and | 28,0000 [US$/km] | |

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| damage after extreme event | | Planning Institute of Jamaica. (s. f.). *Damage and loss assessments — 2008 PIOJ report: Storm Gustav*. https://www.pioj.gov.jm/product/damage-and-loss-assessments-2008-pioj-report-storm-gustav/<br>National Works Agency, Jamaica. (s. f.). *Major infrastructure development programme*. https://www.nwa.gov.jm/major-infrastructure-development-programme<br>Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). *Lifelines: The resilient infrastructure opportunity* (Sustainable Infrastructure Series). World Bank. https://doi.org/10.1596/978-1-4648-1430-3 |
| Benefit – counterfactual: Avoided GDP contraction after extreme event from economic disruption (period 2025-2029) | 987 [US$/km] | Planning Institute of Jamaica. (s. f.). *Damage and loss assessments — 2008 PIOJ report: Storm Gustav*. https://www.pioj.gov.jm/product/damage-and-loss-assessments-2008-pioj-report-storm-gustav/<br>National Works Agency, Jamaica. (s. f.). *Major infrastructure development programme*. https://www.nwa.gov.jm/major-infrastructure-development-programme<br>Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). *Lifelines: The resilient infrastructure opportunity* (Sustainable Infrastructure Series). World Bank. https://doi.org/10.1596/978-1-4648-1430-3<br>World Bank. (s. f.). *GDP (current US$) — Jamaica (NY.GDP.MKTP.KN)*. The World Bank. https://data.worldbank.org/indicator/NY.GDP.MKTP.KN?end=2023&locations=JM&start=1966&view=chart<br>World Bank. (s. f.). *Jamaica country overview*. https://www.worldbank.org/ext/en/country/jamaica<br>Statistical Institute of Jamaica. (s. f.). *National Accounting — Annual GDP*. https://statinja.gov.jm/nationalaccounting/Annual/NewAnnualGDP.aspx |
| Benefit – counterfactual: Avoided GDP contraction after extreme event from economic disruption (period 2030-2039) | 1075 [US$/km] | |
| Benefit – counterfactual: Avoided GDP contraction after extreme event from economic disruption (period 2040-2050) | 1187 [US$/km] | |

### h. Tourism sector

| Data point description | Value [unit] | Source |
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| ***Cost: Defining fish sanctuaries:** hectares of coastal fishery water (down to 30 meters) protected as Fish Sanctuaries | 4.646 US$/ha | Ministry of Tourism. (2020). *Strategic Business Plan 2020/2021 – 2023/2024*. [mots_2020_2024-strategic_business_plan_revised_june_2020.pdf]() |
| ***Cost: Defining fish sanctuaries:** hectares of coastal fishery water (down to 30 meters) protected as Fish Sanctuaries | 31,500 US$/consultation | |
| ***Cost: Extend training of staff:** farmers trained in aquaculture production techniques and good aquaculture practices utilising the Farmer Field School methodology and online training platforms | 1.915 US$/trained farmers | |
| ***Cost: Have robust monitoring and enforcement (by adding staff):** Fisheries data collected from sites – fishing beaches, production plants, etc. Number of sites from which data are obtained. | 28.935 US$/site from which data is obtained | |
| ***Cost: Expand experiences. Areas for consideration include rural and community tourism, nature and eco-tourism, adventure tourism and heritage tourism:** Install 26 storyboards at heritage sites and 12 directional signs. | 4,000,000 US$/heritage site | |
| ***Cost: Expand experiences. Areas for consideration include rural and community tourism, nature and eco-tourism, adventure tourism and heritage tourism:** Upgrade of Heritage Sites and Attractions. Tours expanded and improved. Improvement at King's House, Seville Great House and Trench Town Performance Space. | 23,000,000 US$/heritage site | |
| ***Cost: Expand experiences. Areas for consideration include rural and community tourism, nature and eco-tourism, adventure tourism and heritage tourism:** Tourism Strategy and Action Plan. | 150,000 US$/national tourism plan | |
| ***Cost: Expand experiences. Areas for consideration include rural and community tourism, nature and eco-tourism, adventure tourism and heritage tourism:** Tourism Destination Development and Management and Plan. | 63,490 US$/destination | |
| ***Cot: Implement mechanisms for improved governance of the protected areas system:** Create a comprehensive strategy for actively involving and collaborating with the private sector in initiatives related to protected area management. | 6,300 US$/strategy | Government of Jamaica. (2024). *Overarching Policy for Jamaica's Protected Areas System*. forestry.gov.jm/resourcedocs/Overarching_Policy_for_Jamaica_s_Pr |
| ***Cost: Declare/ designate protected areas:** Identification and inclusion of national biodiversity conservation targets for protected | 63,000 US$/NBSAP | |

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| areas in Jamaica's revised and updated National Biodiversity Strategy and Action Plan (NBSAP). | revised and updated | otected_Areas_System__Green_Paper__-_Public_Consultation.pdf |
| ***Cost: Declare/ designate protected areas:** Integration of climate change adaptation measures in protected area planning, management strategies, and the design of the protected areas system. | 126,000 US$/planning and management strategies with adaptation measures | |
| ***Cost: Declare/ designate protected areas:** Development and Implementation of the National Mangrove and Swamp Forest Management Plan. | 28,350 US$/National Mangrove and Swamp Forest Management Plan | |
| ***Cost: Integrate nature-based solutions:** Develop and execute capacity building programmes, including training at the local and community levels, to support effective PA management. | 63,000 US$/capacity building programme | |
| ***Cost: Increase public education and awareness regarding the protected areas system:** Develop and implement strategies, programmes and plans to increase awareness and understanding of the values and benefits of protected areas and the protected areas system. | 126,000 US$/Public education and awareness strategies and programmes | |
| ***Cost: Increase public education and awareness regarding the protected areas system:** Conduct research to determine the most effective marketing strategies to continuously engage and "market" the benefits of protected areas to the wider public in order to elicit a sense of ownership and to effect behavior change. | 18,900 US$/research | |
| ***Cost: Involve stakeholders in protected areas management:** National Protected Area Database including information on, inter alia, boundaries and size established and maintained. | 157,500 US$/National PA Database | |
| ***Benefit: Average annual tourist expenditure.** | 1.15 US$/tourist | Reid-Grant, K., & Bhat, M. G. (2009). *Financing marine protected areas in Jamaica: An exploratory study. Marine Policy, 33(1), 128–136.* doi:10.1016/j.marpol.2008.05. |
| ***Benefit: Coral reefs -** Opportunities for recreation and tourism. | 6271 US$/hectare/year | Brander, L. M., de Groot, R., Schägner, J. P., Guisado-Goni, V., van't Hoff, V., Solomonides, S., ... & Thomas, R. (2024). Economic values for ecosystem services: A global synthesis and way forward. *Ecosystem Services*, *66*, 101606. https://doi.org/10.1016/j.ecoser.2024.101606 |
| ***Benefit: Mangroves -** Opportunities for recreation and tourism. | 6,118 US$/hectare/year | |

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| ***Benefit:** Tourism earnings per eco-tourism destination. | 59,710 US$/destination | Calculated with the information of Ministry of Tourism. (2020). *Strategic Business Plan 2020/2021 – 2023/2024*. Retrieved from mots_2020_2024-strategic_business_plan_revised_june_2020.pdf |
| ***Benefit:** Money generated per money invested. | 50 US$ generated/US$ invested | Mentefactura. (2009). *Sustainable Financing Plan for Jamaica's System of Protected Areas (JPAS) 2010–2020*. Sustainable Financing Plan for Jamaica's System of Protected Areas 2010-2020 |

### i. Coastal Areas sector

| Data point description | Value [unit] | Source |
|---|---|---|
| ***Cost: Use of ecosystem approach in management of beaches - Coral Reef Restoration (Reattachment of detached coral):** small-scale relocation. | 176 US$/m | World Bank Group. Beach Restoration and Coastal Management Guidelines: Further Recommendations for Research for Jamaica. Retrieved from https://www.gfdrr.org/sites/default/files/publication/Coastal%20Management%20and%20Beach%20Restoration%20Guidelines%20Jamaica%20FINAL.pdf |
| ***Cost: Use of ecosystem approach in management of beaches - Coral Reef Restoration (Reattachment of detached coral):** large-scale relocation. | 100,000 US$/m$^3$ | |
| ***Cost: Use of ecosystem approach in management of beaches - Coral Reef Restoration (Reattachment of detached coral):** artificial reef creation. | 550,000 US$/m$^3$ | |
| ***Cost: Use of ecosystem approach in management of beaches - Coral Reef Restoration (Reattachment of detached coral):** coral reef nurseries. | 1,000,000 US$/m$^3$ | |
| ***Cost: Use of ecosystem approach in management of beaches - Mangrove Restoration: Removal of loose fouling materials (e.g. fishing nets, garbage, loose seaweed fronds):** planting. | 100,000 US$/m$^3$ | |
| ***Cost: Use of ecosystem approach in management of beaches: Mangrove Restoration (Removal of loose fouling materials (e.g. fishing nets, garbage, loose seaweed fronds)):** relocation. | 100,000 US$/m$^3$ | |
| ***Cost: Use of ecosystem approach in management of beaches - Mangrove Restoration (Removal of loose fouling materials (e.g. fishing nets, garbage, loose seaweed fronds)):** afforestation. | 550,000 US$/m$^3$ | |
| ***Cost:** Increasing the number of monitoring stations, enhancing the real time monitoring of water levels and intensity at rainfall stations: cost description. | 323,392 US$/upgraded flood early warning system | Caribbean Development Bank. (2017). *Technical Assistance - Upgraded Flood Early Warning System for The Rio Cobre Watershed - Jamaica*. BD91_17_Jamaica_TA_Upgraded Flood Early Warning System for the Rio Cobre Watershedredactedt.pdf |
| ***Cost:** Cost-effective mechanisms for relaying real time data and transferring information to key stakeholders: cost description. | | |
| ***Benefit: Coral reefs –** Ecosystem services, excluding opportunities for recreation and tourism. | 80,940 US$/hectare/year | Brander, L. M., de Groot, R., Schägner, J. P., Guisado-Goni, V., van't Hoff, V., Solomonides, S., ... & Thomas, R. (2024). Economic values for ecosystem services: A global synthesis and way forward. *Ecosystem Services*, *66*, 101606. |
| ***Benefit: Mangroves -** Ecosystem services, excluding opportunities for recreation and tourism. | 71,810 US$/hectare/year | |

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| | | https://doi.org/10.1016/j.ecoser.2024.101606 |
| ***Benefit - Counterfactual: Early warning systems –** Average annual losses prevented from hurricanes and floods. | 182,000 US$/hurricanes and floods per year | Caribbean Development Bank. (2017). *Technical Assistance - Upgraded Flood Early Warning System for The Rio Cobre Watershed - Jamaica*. BD91_17_Jamaica TA Upgraded Flood Early Warning System for the Rio Cobre Watershedredactedt.pdf |

### j. Culture and Heritage sector

| Data point description | Value [unit] | Source |
|---|---|---|
| ***Cost:** Elevate structures. | 2,300 US$/site | International Bank of Development and CEAC Solutions Company Limited. (2024). *Interventions to Increase Climate Resilient Investments in Barbados, Jamaica and Trinidad and Tobago*. Retrieved from https://idbinvest.org/en/publications/interventions-increase-climate-resilient-investments-barbados-jamaica-and-trinidad-and |
| ***Cost:** Elevate equipment. | 11,400 US$/site | |
| ***Cost:** Install hurricane / wind roof clips and tides. | 1,200 US$/site | |
| ***Cost:** Install impact resistant windows and doors. | 1,800 US$/site | |
| ***Cost:** Install high efficiency toilets. | 1,200 US$/site | |
| ***Cost:** Install water efficient faucets and shower heads. | 1,900 US$/site | |
| ***Cost:** Install tanks for rainwater collection. | 8,600 US$/site | |
| ***Cost:** Prodex 10mm insulation and radiant barrier. | 4,500 US$/site | |
| ***Cost:** Use of light weight concrete walls instead of blocks. | 7,100 US$/site | |
| ***Cost:** Install double glazed windows. | 12,875 US$/site | |
| ***Benefit:** Elevate structures. | 12,875 US$/site | |
| * **Benefit:** Elevate equipment. | 1,060 US$/site | |
| * **Benefit:** Install hurricane / wind roof clips and tides. | 2,120 US$/site | |
| * **Benefit:** Install impact resistant windows and doors. | 900 US$/site | |
| * **Benefit:** Install high efficiency toilets. | 375 US$/site | |
| * **Benefit:** Install water efficient faucets and shower heads. | 5,733 US$/site | |
| * **Benefit:** Install tanks for rainwater collection. | 28,785 US$/site | |
| * **Benefit:** Prodex 10mm insulation and radiant barrier. | 488 US$/site | |
| * **Benefit:** Use of light weight concrete walls instead of blocks. | 1,723 US$/site | |
| * **Benefit:** Install double glazed windows. | 12,875 US$/site | |

## k. Population and Health Sector

| Data point description | Value [USD] | Source |
|---|---|---|
| The National Disaster Fund. The ODPEM is authorized to spend a maximum of J$ 4 million annually. Converted to USD dollars= 25 189 USD/annually. We are assuming an extra same amount for this plan. | 25 189 / year | Government of Jamaica & World Bank. (2019). Jamaica post-disaster budget execution guidelines. World Bank. https://documents1.worldbank.org/curated/en/194591594113173864/pdf/Jamaica-Post-Disaster-Budget-Execution-Guidelines.pdf |
| Rehabilitation works after a natural disaster. There are natural disasters with significant costs every 2,5 years approximately and the mean of costs is almost 4 MUSD. So (2*4)/2,5= 3,2 MUSD/ 2 year | 3 200 000 / 2 years | World Bank & Global Facility for Disaster Reduction and Recovery. (2018). Advancing disaster risk finance in Jamaica (GFDRR report). World Bank. https://www.gfdrr.org/sites/default/files/publication/Advancing-Disaster-Risk-Finance-in-Jamaica.pdf |
| Cash grants in response to disaster recovery. 10% of Jamaica's populations receives help by year for disasters recovery= 300,000 people , so 75 000 families every two years. The Rehabilitation Program provided support of $203 USD to individual in 2017. We are assuming a grant of 250 USD/ family / 2 years | 250 USD / family / 2 years | World Food Programme & Oxford Policy Management. (2020). *Shock-responsive social protection in Jamaica: Case study* (Caribbean research programme on shock-responsive social protection). World Food Programme. https://socialprotection.org/discover/publications/case-study-shock-responsive-social-protection-jamaica |
| There is a multiplier effect for Rehabilitation works after a natural disaster: When there is a grant or an investment in specific situations as natural disasters, the benefit will be seen some years later but the effect is x2 or x3 the investment that was done. We assume the effect will be 1.5 times the cost. 3.2MUSD *1.5= 4.8 MUSD. | 4 800 000 / 2 years | The Patterson Foundation. (2016, September 29). The multiplier effect. The Patterson Foundation. https://www.thepattersonfoundation.org/blog/cdp/the-multiplier-effect.html |
| There is a multiplier effect for Cash grants in | 28 125 000 / 2 years | The Patterson Foundation. (2016, September 29). The multiplier effect. |

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|---|---|---|
| response to disaster recovery: When there is a grant or an investment in specific situations as natural disasters, the benefit will be seen some years later but the effect is x2 or x3 the investment that was done. We assume the effect will be 1.5 times the cost. 75000 families *250 usd grant = 18 750 000 USD * 1.5 = 28 125 000 USD | | The Patterson Foundation. https://www.thepattersonfoundation.org/blog/cdp/the-multiplier-effect.html |
| Supervision of Construction Works for the Upgrading of Community Sports Facilities. Cost is 21,365.72 USD. We assume with that money they can upgrade 5 facilities, so 21365.72/5 = 4273 USD/ upgrading sport facility. We assume 25 upgrades / year | 4273 / sport facility upgraded | World Bank. (2020). Jamaica Integrated Community Development Project: Procurement plan. World Bank. https://documents1.worldbank.org/curated/en/963501595626744589/pdf/Jamaica-LATIN-AMERICA-AND-CARIBBEAN-P146460-Jamaica-Integrated-Community-Development-Project-Procurement-Plan.pdf |
| Provision of bins for community storage of Waste. We assume 25 parks a year with new waste bins and 10 bins /park =250 bins/year. We assume every bin costs 20USD | 20 USD / bin | World Bank. (2020). Jamaica Integrated Community Development Project: Procurement plan. World Bank. https://documents1.worldbank.org/curated/en/963501595626744589/pdf/Jamaica-LATIN-AMERICA-AND-CARIBBEAN-P146460-Jamaica-Integrated-Community-Development-Project-Procurement-Plan.pdf |
| Procurement of garbage trucks. We assume 1 garbage truck every 2 years. | 137 887.52 / garbage truck / 2 years | World Bank. (2020). Jamaica Integrated Community Development Project: Procurement plan. World Bank. https://documents1.worldbank.org/curated/en/963501595626744589/pdf/Jamaica-LATIN-AMERICA-AND-CARIBBEAN-P146460-Jamaica-Integrated-Community-Development-Project-Procurement-Plan.pdf |
| Community waste management assessment. 50,543.79 USD (year 1), 107,405.23 (year 2) and 94,228.38 (year 3). The mean is 84 058 | 84 058 / year/ community | World Bank. (2020). Jamaica Integrated Community Development Project: Procurement plan. World Bank. https://documents1.worldbank.org/curated/en/963501595626744589/pdf/Jamaica-LATIN-AMERICA-AND- |

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|---|---|---|
| USD/year. We assume this is a value for community. We assume 1 assessment per year. | | CARIBBEAN-P146460-Jamaica-Integrated-Community-Development-Project-Procurement-Plan.pdf |
| Value of diabetes treatment avoided by physical activity due to green areas creation. People in Jamaica with diabetes is 8%.<br>If 200 people benefit from each park for physical activity, an 8% incidence of diabetes is assumed which equals 16 people. Exercise reduces the incidence by 50% =8 people will not have diabetes * 5 parks = 40 people/year.<br>5% of Jamaica's GDP goes towards the treatment of diabetes and hypertension. We assume people with diabetes and hypertension is 1 126 400.<br>$14,26 Billion USD in 2013, a 5% of that is 713 million USD / 1126400 people= 663 990 USD/person | 663 990 / person | Cohen, M., Burrowes, K., & Gwam, P. (2022). The health benefits of parks and their economic impacts: A review of the literature (Research to Action Lab report). Urban Institute. https://www.urban.org/sites/default/files/2022-03/the-health-benefits-of-parks-and-their-economic-impacts_0.pdf<br>Ministry of Agriculture and Fisheries, & Ministry of Health. (2018). National food and nutrition security policy. Government of Jamaica. https://www.moa.gov.jm/sites/default/files/pdfs/National%20Food%20and%20Nutrition%20Security%20Policy.pdf |
| Value of cancers treatment avoided by physical activity due to green areas creation. Physical activity reduces cancer incidences in 30%. In a population of 2961161 in Jamaica by 2020, 18256 people had cancer. That is 0,6% of the population. We assume 200 people gets to make physical activity in the new park, and assuming 0,6 of them is probably avoiding getting cancer = 1. 1 person * 5 parks/year = 5 people/year.<br>Cancers cost low-income countries 0.26% of GDP. | 1 971 954 USD / park | Cohen, M., Burrowes, K., & Gwam, P. (2022). The health benefits of parks and their economic impacts: A review of the literature (Research to Action Lab report). Urban Institute. https://www.urban.org/sites/default/files/2022-03/the-health-benefits-of-parks-and-their-economic-impacts_0.pdf |

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|---|---|---|
| 13,81 billion USD was the GDP in 2020 for Jamaica. So, a 0,26 of that is 36000 million USD / 18256 = 1 971 954 USD/ person or park | | |
| Costs of treating any water-borne disease avoided by improving quality water access. Population with limited water or soap 16%. Population having no hygiene facility 17%. 17% + 8% (Assuming half of the one with limited service) = 25%. = 709786 people. Cost of treating diarrhoea was 134.26 USD/ case in 2015. We assume the same cost for any water-borne disease and converted to 2024 is 182.27 USD | 182,27 / case / year | Average cost of a diarrhea case - Defeat DD<br><br>Planning Institute of Jamaica. (2022). Voluntary national review: Goal 6 — Ensure availability and sustainable management of water and sanitation for all. Planning Institute of Jamaica. https://www.pioj.gov.jm/wp-content/uploads/2022/10/VNR_Goal_6.pdf |
| Benefit obtained by air purification from parks or green areas. As parks are 1 ha size, we assume 1 ha with purified air / park created. The mean of parks created between 2025-2050 by year is 2.6 parks. | 4687 park / year | Stults, S. (2018). A spatial analysis of northern Guatemala. Docslib. https://docslib.org/doc/9371168/a-spatial-analysis-of-northern-guatemala |
| Water Supply Development Strategy for Non-Utility Service Areas. It is assumed it will be developed in 5 years. | 35 200 000 / year | Water Resources Authority. (2019). *National water sector policy*. Government of Jamaica. https://www.wra.gov.jm/wp-content/uploads/2019/03/FINAL-National-Water-Sector-Policy-2019a-Jan-08-19.pdf |
| Provision of mosquito nets and meshed drum covers. 7140.89 USD was spent on mosquito nets/year. Assuming 20 USD/net = 357nets /year | 20 / year / 357 mosquito nets | World Bank. (2020). Jamaica Integrated Community Development Project: Procurement plan. World Bank. https://documents1.worldbank.org/curated/en/963501595626744589/pdf/Jamaica-LATIN-AMERICA-AND-CARIBBEAN-P146460-Jamaica-Integrated-Community-Development-Project-Procurement-Plan.pdf |
| Activities to prevent the post-hurricane spread of | 2 500 000 / campaign / year | United Nations Economic Commission for Latin America and the Caribbean. |

| | | |
|---|---|---|
| vector borne diseases. An estimated US$ 2.1 million is utilized each year in conducting activities. We assume 2.5 million will be spent on that | | (2011). An assessment of the economic impact of climate change on the health sector in Jamaica (LC/CAR/L.316). ECLAC Subregional Headquarters for the Caribbean. https://www.cepal.org/en/publications/38600-assessment-economic-impact-climate-change-health-sector-jamaica |
| Costs of park/green areas constructions. 5 parks every 2 years. 55 USD/ foot² = 592 USD/m². Assuming the price will be half of that= 296 USD/ m². Assuming 10000 m²/park = 296*10000=2.96MUSD/park | 2 960 000 / park | Sisson, P. (2023, October 5). Cities need to build faster, cheaper public parks. Bloomberg. https://www.bloomberg.com/news/features/2023-10-05/cities-need-to-build-faster-cheaper-public-parks |
| Improvement in tourism generated by improving water quality and access and increasing green areas. Assuming this generates 1% more profits from tourism. 2,12 billion in 2012. So a 1% of that is 2,12 Million US dollars. And we assume benefits will start in 2035 | 2 120 000 / year | WorldData.info. (n.d.). Tourism in Jamaica. https://www.worlddata.info/america/jamaica/tourism.php |
| Transport costs to the health facility avoided by improving water service. 1.25 USD/ patient in 2011, converted to 2024 is 2.31 USD/ patient. Population with no hygiene facility 17%. 17% + 8% (Assuming half of the one with limited service) = 25%. = 709786 people. | 2.31 / person | Organisation for Economic Co-operation and Development. (2019). The benefits of investing in water and sanitation: An OECD perspective (OECD Studies on Water). OECD Publishing. https://www.oecd.org/en/publications/benefits-of-investing-in-water-and-sanitation_9789264100817-en.html |
| Livelihood Protection Policy (LPP) for low-income individual after a weather event. Jamaica's populations receives help by year for disasters recovery= 300,000 people, so 75 000 families every two years. Assuming a quarter of that = 18750 people. Half of the mean | 1100 USD / person /year | World Bank & Global Facility for Disaster Reduction and Recovery. (2018). Advancing disaster risk finance in Jamaica (GFDRR report). World Bank. https://www.gfdrr.org/sites/default/files/publication/Advancing-Disaster-Risk-Finance-in-Jamaica.pdf |

| | | |
|---|---|---|
| that this policy give to people is 1100 USD. | | |
| There is a multiplier effect for Livelihood Protection Policy (LPP): When there is a grant or an investment in specific situations as natural disasters, the benefit will be seen some years later but the effect is x2 or x3 the investment that was done. We assume the effect will be 1.5 times the cost. 18750 LPP's * 1100 USD = 20 625 000USD * 1.5 = 30 937 500USD | 30 937 500 / 2 years | The Patterson Foundation. (2016, September 29). The multiplier effect. The Patterson Foundation. https://www.thepattersonfoundation.org/blog/cdp/the-multiplier-effect.html |

2. **Sectoral models: scenarios**

a. **Electricity sector**

| Action | Business-As-Usual (BAU) | Long-Term Strategy (LTS) |
|---|---|---|
| Deploy intermittent renewables | Up until 2038, adheres to the 2018 Jamaica Integrated Resource Plan. For 2038-2050, the model optimizes electricity generation based on total cost. | Up until 2038, the strategy aligns with the 2018 Jamaica Integrated Resource Plan. By 2050, the energy mix is projected to consist entirely of renewables. |
| Reduce system losses | T&D losses stay constant at 25%. | T&D losses will by 8% by 2050. |
| Energy Storage with batteries | By 2038, 540 MW of battery energy storage systems (BEES) installed. | By 2038, 540 MW of BESS will be installed. By 2050, BESS will account for 22% of the total installed capacity of power plants. |
| Energy demand growth | Growth according to Jamaica's GDP. | Growth rates are according to Jamaica's GDP. |
| Cookers electrification | - | In 2035, kerosene, wood and charcoal stoves will be replaced with electrical options.<br>By 2050, no new LPG cookers will be in the market, and the amount in use will be reduced to 9% of the BAU scenario, in 2050. |
| Energy efficiency in existing buildings | - | Use of solar water heating will be reduced 2% of traditional heaters by 2030, and 3% by 2050 relative to BAU scenario.<br>In 2030, replace 100% of electric lighting with LED lamps (1,177,626 units), or equivalents, in residential, public and commercial buildings.<br>In 2040, replace electrical units in existing buildings, relative to 2021:<br>• 1,178,797 refrigeration units<br>• 17,925 AC units |
| Low carbon materials | 100% of newly constructed houses utilize conventional building materials. | By 2050, it is projected that 50% of new residential constructions will employ low-carbon building materials. |

### b. Transport sector

| Action | Business-As-Usual (BAU) | Long-Term Strategy (LTS) |
|---|---|---|
| Fleet electrification | By 2030 1% of cars, motorcycles, SUV, taxis, public buses, and minibuses are electric.<br>By 2050 6% of cars, motorcycles, SUV, taxis, public buses, and minibuses are electric. | By 2030 12% of private vehicle fleet (cars, motorcycles, SUV) and 16% of the public fleet (taxis, buses and minibuses) are electric.<br><br>By 2050 67% of passenger fleet (private and public vehicles) are electric.<br><br>Deploy at least 2,000 electric buses by 2040. |
| Efficiency improvements | Efficiency improvements are not considered. | By 2030 efficiency of vehicle fleet (passenger and freight) is improved by 15% from 2020 levels.<br><br>By 2050 reduce trucks' fuel consumption by 40% relative to 2020 levels through efficiency improvements. |
| Modal-shift | There is no modal-shift considered. | The use of public transport increases to 35% by 2030.<br><br>Non-motorized transport increases to 3% by 2030 and 5% by 2050. |

### c. Industrial sector

| Action | Business-As-Usual (BAU) | Long-Term Strategy (LTS) |
|---|---|---|
| Clinker substitution (replacing clinker with natural pozzolans). | The Clinker-to-cement ratio is reduced to 82% in 2025 and will remain constant until 2050. | The Clinker-to-cement ratio is reduced to 82% in 2025 and to 70% 2030. |
| Energy efficiency improvements | - | By 2030, a reduction of 25% of fuel consumption for alumina processing relative to 2020 is achieved.<br>By 2050, a reduction of 15% in Industry sector energy intensity (quantity of energy required per unit output or activity) relative to 2020 levels is achieved. |
| Reduction of coal used in cement production | - | By 2040, a reduction of 6% of coal used in cement relative to 2020 levels is achieved using recycled materials or biomass. |
| Efficient mining processes: Reduction of bauxite extraction energy intensity to meet European standards per tonne of bauxite extracted[6] | - | By 2040, an energy intensity of 105 MJ/tonne of bauxite extracted is achieved. |

[6] Cozzi, Paolo, UnaMay Gordon, Rodrigo Narvaez, Arunima Sircar, and Diego Becerra Torralva. “Jamaica’s Long-Term Emissions Reduction and Climate Resilient Strategy Operationalisation Plan.” Climate Analytics, 2023.

### d. Waste sector

| Action[7] | Business-As-Usual (BAU) | Long-Term Strategy (LTS) |
|---|---|---|
| Improving waste separation, increasing recycling projects and plants and promoting composting as an alternative treatment option. | No reduction of organic matter in landfills. | Organic matter recycling: 50% reduction of organic matter in landfills relative to 2020 levels via composting by 2050. |
| Reduce improper disposable of garbage by implementing waste-to-energy projects. | - | This policy lever is purely qualitative in the LTS; therefore, more information is needed for it to be considered in the future. |
| Reduce the adverse impacts of waste on the environment and public safety with well-managed waste infrastructure. | - | Recycling of domestic wastewater: By 2035, 50% of domestic wastewater will be recycled.<br><br>More data is required to consider additional well-managed waste infrastructure. |
| Develop and enforce solid waste management regulations. | - | This policy lever is purely qualitative in the LTS; therefore, more information is needed for it to be considered in the future. |

[7] Cozzi, Paolo, UnaMay Gordon, Rodrigo Narvaez, Arunima Sircar, and Diego Becerra Torralva. "Jamaica's Long-Term Emissions Reduction and Climate Resilient Strategy Operationalisation Plan." Climate Analytics, 2023.

### e. Food security sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Climate Smart Agriculture | Expansion of agroforestry systems | 34100 hectares | Validated during workshop |
| | Implementation of terrace systems | 5683 hectares | Input from workshop |
| | Crop rotation in annual crops | 5% of the cropland (17050 hectares) | Validated during workshop |
| | Implementation of conservation tillage | 5% of the cropland (17050 hectares) | Validated during workshop |
| | Implementation of intercropping in annual crops | 5% of the cropland (17050 hectares) | Jamaica Information Service. (2020, January 7). Get the facts: Climate-smart farming practices. Jamaica Information Service. https://jis.gov.jm/information/get-the-facts/get-the-facts-climate-smart-farming-practices/ |
| | Installation of cold storage facilities | 25 facilities | Input from workshop |
| | Drone acquisition | 1250 drones | Input from workshop |
| | Training farmers in drone use | 1250 trainings | Validated during workshop |
| | Trainings on climate smart agriculture | 6000 trainings | Validated during workshop |
| Innovative irrigation methods | Implementation of rainwater harvesting systems with a capacity of 680 m³ each | 125 systems | Jamaica Information Service. (2020, January 7). Get the facts: Climate-smart farming practices. Jamaica Information Service. https://jis.gov.jm/information/get-the-facts/get-the-facts-climate-smart-farming-practices/ |
| | Implementation of drip irrigation | 4975 hectares | Ministry of Agriculture & Fisheries. (2021). Quarterly performance review report: April – June 2021 (First Quarter Final Revised). Government of Jamaica. https://www.moa.gov.jm /sites/default/files/pdfs/MOAF-1st-quarter-finalrevised1.pdf |
| | Subsurface irrigation | 1245 hectares | Input from workshop |
| | Training farmers in the use of irrigation | 2500 trainings | UNEP Copenhagen Climate Centre & United Nations Environment Programme. (2022). Agriculture sector policy brief: Jamaica. https://tech-action.unepccc.org/wp-content/uploads/ sites/2/2022/02/agriculture-sector-policy-brief-jamaica.pdf |
| Climate-Resilient Crop Substitution | Pest and disease-tolerant varieties implementation | 5% of the cropland (17050 hectares) | Validated during workshop |
| | Heat-tolerant varieties implementation | 5% of the cropland (17050 hectares) | Validated during workshop |
| | Water stress-tolerant varieties implementation | 5% of the cropland (17050 hectares) | Validated during workshop |
| | Flood tolerant varieties implementation | 5% of the cropland (17050 hectares) | Input from workshop |

| | | | |
|---|---|---|---|
| | Wind tolerant varieties of banana | 1400 hectares | Input from workshop |
| | Development of insect production systems (farms), each measuring 100 $m^2$ | 13 insect farms | Input from workshop |
| | Adoption of Hydroponic fodder production for livestock | Projected to reach 5% of livestock by 2050 | Input from workshop |
| | Cassava root meal as substitute for maize in animal feed | 30% of maize used for animal feed is replaced by cassava | Agriculture Task Force. (2009). Vision 2030 Jamaica: Final draft agriculture sector plan. Vision 2030 Jamaica. https://www.vision2030.gov.jm/wp-content/uploads/sites/ 2/2020/12/Microsoft-Word-Vision-2030- Jamaica-Final-Draft-Agriculture-Sector-Plan-%E2%80%A6.pdf |
| | Implementation of vertical farming | 25 facilities | Input from workshop |
| | Provision of sweet potato planting material | 625 hectares | Input from workshop |
| | Trainings on sweet potato technical management | 375 trainings | Validated during workshop |

### f. Terrestrial ecosystems sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Forest governance and biodiversity conservation | Implementation of a mechanism for integrating the Forest Sector into national decision-making processes. | Implementation to continue from 2027 to 2031 | Forestry Department, Government of Jamaica. (2022). *Strategic Forest Management Plan 2021–2026*. https://www.forestry.gov.jm/resourcedocs/Strategic_Forest_Management_Plan_2021_-_2026-Final.pdf |
| | Amend the Forest Act and its regulations | Implementation to continue from 2027 to 2031 | |
| | Development Orders prepared and updated regarding forest management priorities | Implementation to continue from 2027 to 2031 | |
| | Transfer by the Commissioner of Lands, crown lands to the Forestry Department | Implementation to continue from 2027 to 2031 | |
| | Strengthening of the approaches governing issues of tenure and trespass on forest estates | Implementation to continue from 2027 to 2031 | |
| | Development of regulations that permit and license activities such as: special recreational use, research and others | Implementation to continue from 2027 to 2031 | |
| | Expansion of the boundary verification programme for forest estates | Implementation to continue from 2027 to 2031 | |
| | Develop and Lead Forest Invasive Species Control Plan | Implementation to continue from 2027 to 2050 | |
| | Pilot Conservation Plans and Species Mapping | Implementation to continue from 2027 to 2050 | |
| Agroforestry and Ecosystem Restoration | Increase forest cover | 14500 hectares | |
| | Increase mangroves cover | 4000 hectares | |

| | | | |
|---|---|---|---|
| | Increase forest conservation | 14500 hectares | |
| | Improvement and development of Forest Management Plans (FMP) | 72 plans | |
| | Protection and enforcement in forests, includes patrol plans and rangers reports, surveillance | 14500 hectares | |
| | Riparian forest guidelines and management practices developed and implemented | Implementation to continue from 2027 to 2030 | |
| | Implementation and expansion of the plant nursery program | Implementation to continue from 2025 to 2028 | |
| | Implementation of silviculture trainings for relevant agencies staff | 12 trainings | |
| | Establishment of Permanent Sample Plots (PSP) | 96 plots | |
| | Establishment of Agroferestry Demo plats in degradated land scopes | 96 plats | |
| | Installation of tissue culture lab | 1 lab | |
| | Processing of weather data | monthly data processing of 4 weather stations | |
| | Improvement of tree species data availability | 12 tree species data (1 specie every two years) | |
| | Native trees planting initiative in urban and rural areas | 1200000 tress | Input from workshop |
| | Strengthen legal protection for ancient and native trees | Implementation from 2026 to 2029 | Validated during workshop |
| | Public awareness campaigns of ancient and native trees | 5 campaigns | Validated during workshop |

| | | | |
|---|---|---|---|
| | Monitoring and reporting about ancient and native trees | 1 monitoring every two years | Validated during workshop |
| | Improvement of governance and decision making processes to complement the REDD+ and Cancun safeguards across the forestry sector | Implementation from 2026 to 2050 | Input from workshop |
| | Carbon (MRU) under REDD+ monitoring, reporting and verification | 1 monitoring every two years | Input from workshop |

## g. Human settlements and critical infrastructure

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Reduce vulnerability of populations living in informal settlements | Housing unit construction | 2500 units/year | Jamaica Information Service. (2020, September 14). Get the facts: The indigent housing programme. Jamaica Information Service. https://jis.gov.jm/information/get-the-facts/get-the-facts-the-indigent-housing-programme/ |
| Increase roll-out of low carbon cooling initiatives in urban and rural settlements | Roll-out of energy efficient AC units | 754 AC units/year | National Environment and Planning Agency. (n.d.). *Caribbean Cooling Initiative*. https://www.nepa.gov.jm /ozone/caribbean-cooling-initiative |
| Development of microinsurance products for post-disaster recovery | Microfinance institutions receiving technical assistance to develop microinsurance products | 5 institutions and 1,392,000 people | Ministry of Finance & the Public Service. (2021). National Natural Disaster Risk Financing Policy: Green paper (2021–2026). Government of Jamaica. https://www.mof.gov.jm/wp-content/uploads/National-Natural-Disaster-Risk-Financing-Policy-Green-Paper-Final.pdf |
| Build seawalls and other defenses to protect key coastal assets | Construction of grey infrastructure protection measures | 80 km | Government of Jamaica. (2017). National Coastal Management and Beach Restoration Guidelines for Jamaica. Global Facility for Disaster Reduction and Recovery. https://www.gfdrr.org/sites/default/files/publication/Coastal%20Management%20and%20Beach%20Restoration%20Guidelines%20Jamaica%20FINAL.pdf |
| Plan and implement coastal retreat or inland relocation to manage erosion risks. | Managed coastal relocation | 324.373 | National Coastal Management and Beach Restoration Guidelines for Jamaica |
| Conduct climate vulnerability and risk assessments (CCVA) | Community-level CCVA | 48 communities | Government of Jamaica. (2024). Climate Risk Assessment Methodology for projects in the Public Investment Management System (Version August 2024). Ministry of Finance & Public Service. https://www.mof.gov.jm/wp-content/uploads/GOJ-Climate-Risk-Assessment-Methodology-20241010.pdf |
| Adapt by integrating Nature-based Solutions (NbS) | Construction of artificial wetlands for secondary/tertiary wastewater treatment | 6.02 MCM/year or 5.3 ha/year | Reid, T.-A., & Quest, W. (2017, October 6). Kingston as an ecological space: Ecological spaces in urban communities. Paper presented at the Caribbean Urban Forum 2017. FDPI. https://www.fdpi.org/wp-content/uploads/2017/10/Kingston-as-an-Ecological-Space_Reid-and-Quest_CUF-2017.pdf |
| Adapt water infrastructure to climate variability | Construction of new water pipelines | 1644 km of new pipelines by 2030 (274 km new pipelines per year) | Office of the Prime Minister. (2024, June 4). $24.8 Billion Western Water Resilience Project to relieve water woes in Negril and western parishes. Government of Jamaica. https://opm.gov.jm/24-8-billion-western-water-resilience-project-to-relieve |

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|---|---|---|---|
| | | | -water-woes-in-negril-and-western-parishes/ |
| | Retrofitting of water supply pipelines | 233 km/year | Idem |
| | Maintenance of water supply pipelines | 233 km/year | Idem |
| | Retrofitting of WWTP | 0.64 MCM/year | Idem |
| | Retrofitting of sewerage pipelines | 2.48 MCM/year | Idem |
| | Installation of RWHS (catchment tanks) | 24 new units/year | Idem |
| | Reduction of non-revenue water (NRW) | 30% of NRW | Idem |
| Enhance the resilience of transportation infrastructure | Retrofitting of roads (major works) | 450 km/year | National Works Agency. (n.d.). Major Infrastructure Development Programme. National Works Agency. Retrieved January 9, 2026, from https://www.nwa.gov.jm/major-infrastructure-development-programme |
| | Road rehabilitation (minor works) | 450 km/year | Transport Task Force. (2009). Vision 2030 Jamaica: Final draft transport sector plan (Transport Sector Plan 2009-2030). Vision 2030 Jamaica. https://www.vision2030.gov.jm/wp-content/uploads/sites/2/2020/12/Microsoft-Word-Vision-2030-Jamaica-Final-Draft-Transport-Sector-Plan-_S%E2%80%A6.pdf |

## h. Tourism sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Reduction in overfishing and illegal fishing practices. | Define fish sanctuaries (hectares of coastal fishery water) | 20,000 hectares by 2026 and to held 2 consultations in 2024 | Ministry of Agriculture, Fisheries and Mining. (n.d.). Strategic plans. Government of Jamaica. Retrieved January 9, 2026, from https://new.moa.gov.jm/document-categories/strategic-plans |
| | Farmers trained in aquaculture | To train 34 farmers per year from 2023 till 2026, and 45 farmers from 2026 to 2027 | Idem |
| | Have robust monitoring and enforcement (by adding staff) | To monitor 324 sites each year from 2023 to 2027 | Idem |
| Diversify and invest in tourism by highlighting Jamaica's cultural heritage and natural environment | Install 26 storyboards at heritage sites and 12 directional signs. | Upgrade 3 eco-tourism destination each year, from 2025 to 2046 | Ministry of Tourism. STRATEGIC BUSINESS PLAN 2020/2021 - 2023/2024. Jamaican Heritage Sites |
| | Upgrade of Heritage Sites and Attractions. Tours expanded and improved. | Upgrade 3 eco-tourism destination each year, from 2025 to 2046 | Ministry of Tourism. STRATEGIC BUSINESS PLAN 2020/2021 - 2023/2024. Jamaican Heritage Sites |
| | Develop a Tourism Strategy and Action Plan | Every 10 years, from 2025 to 2045 | Ministry of Tourism. STRATEGIC BUSINESS PLAN 2020/2021 - 2023/2024. |
| | Develop a Tourism Destination Development and Management and Plan | For 3 eco-tourism destination each year, from 2025 to 2046 | Ministry of Tourism. STRATEGIC BUSINESS PLAN 2020/2021 - 2023/2024. |
| Land management standards to reduce runoff of sediment and fertilizers | Implementation of mechanisms for improved governance of the protected areas system | 1 strategy created in 1 year (2025) | National Environment and Planning Agency. (2024, June 18). Overarching Policy for Jamaica's Protected Areas System (Green Paper) – Public Consultation. Government of Jamaica. https://www.nepa.gov.jm/sites/default/files/2024-06/Overarching%20Policy%20for%20Jamaica's%20Protected%20Areas%20System%20(Green%20Paper)%20-%20Public%20Consultation.pdf |
| | Update of the National Biodiversity Strategy and Action Plan (NBSAP) | 1 plan revised in 1 year (2025) | Idem |

| | | | |
|---|---|---|---|
| | Integration of climate change adaptation measures in protected area planning | 10 plan or strategy with adaptation measures in 10 years, from 2025 to 2035 | Idem |
| | Development and Implementation of the National Mangrove and Swamp Forest Management Plan. | 1 plan developed in 1 year (2025) and implemented during 9 years | Idem |
| | Develop and execute capacity building programs | 30 capacity building programs measures in 10 years (3 capacity building programs each year) | Idem |
| | Develop and implement strategies to increase awareness of protected areas | 10 public education programs in 5 years (2 education programs each year) | Idem |
| | Research to determine the most effective marketing strategies to engage and "market" the benefits of protected areas | 2 research each year from 2026 to 2027 | Idem |
| Strengthen and promote protected areas through a comprehensive policy framework | Involve stakeholders in protected areas management | 157,500 US$ in 5 years. 31,500 US$ each year from 2025 to 2030 | Idem |

### i. Coastal Areas sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Expand reef restoration practices | Coral reef restoration by reattachment of detached coral | 62.5 ha each year from 2025 to 2028 and 160 ha each year from 2029 to 2050 | Raynor Chanel. (2024). Early Warning systems must protect everyone within five years.<br>IKI. (2024). CoralCarib.<br>The Nature Conservacy. (2022). Coral Refugia<br>Reef Restoration Network. (2023). Taller del Plan de Acción de Restauración de CoralCaribe Intercambio de Aprendizaje |
| Expand mangrove conservation and restoration | Removal of loose fouling materials, planting, afforestation, relocation | Increase 4000 ha of mangroves from 2025 to 2050 (160 ha/year) | Jamaica's Long Term Strategy |
| Develop and implement early warning systems (EWS) and risk preparedness measures | Increase the number of monitoring stations | Upgrade the flood early warning system once between 2025 and 2027 | World Meteorological Organization. (2022). Early Warnings for All. |
| Develop and implement early warning systems (EWS) and risk preparedness measures | Cost-effective mechanisms for relaying real-time data and transferring information to key stakeholders. | | |

### j. Culture and heritage sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Climate-resilient inventory and risk management system for cultural heritage assets. | Elevate structures. | 2 Heritage Sites each year from 2025 to 2045 | IDB Invest. (2023, February 11). Interventions to increase climate resilient investments in Barbados, Jamaica and Trinidad and Tobago: Identification of hazards and resilience measures. Inter-American Development Bank Group. https://idbinvest.org/en /publications/interventions-increase-climate-resilient-investments-barbados-jamaica-and-trinidad-and |
| | Elevate equipment | 2 Heritage Sites each year from 2025 to 2045 | |
| | Install hurricane / wind roof clips and tides. | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Install impact resistant windows and doors | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Install high efficiency toilets | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Install water efficient faucets and shower heads. | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Install tanks for rainwater collection. | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Prodex 10mm insulation and radiant barrier. | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Use of light weight concrete walls instead of blocks. | In 2 Heritage Sites each year from 2025 to 2045 | |
| | Install double glazed windows. | In 2 Heritage Sites each year from 2025 to 2045 | |
| Collaboration with indigenous communities to preserve and document traditional knowledge | Develop a database for intangible culture: An average of an external an in-house development costs. | 1 data base developed in 5 years. Updated every 10 years. | United Nations Educational, Scientific and Cultural Organization. (2011, September 6). Information analysis and feasibility study regarding the voluntary information exchange of measures for implementing the Second Protocol (Document CLT-11/CONF/211/4). UNESCO. https://unesdoc.unesco.org /ark:/48223/pf000023122 |

### k. Population and health sector

| LTS action | Specific strategy | Target | Source |
|---|---|---|---|
| Water quality and sanitation supply | Water Supply Development Strategy for Non-Utility Service Areas | 15% of the population | Water Resources Authority. (2019). National Water Sector Policy (Final version, January 8, 2019). Government of Jamaica. https://www.wra.gov.jm/wp-content/uploads/2019/03/FINAL-National-Water-Sector-Policy-2019a-Jan-08-19.pdf |
| | MAR (Managed aquifer recharge) scheme | two aquifers | Input from workshop |
| | Implementation of Aquifer Protection zones APZ | 25 Aquifer Protection zones (1 per year) | Input from workshop |
| | Aquifer monitorings | Annually | Input from workshop |
| Presence and access to green areas and park areas | Park or green areas constructions of 10000m2 each | 40 new public parks or green areas by 2050 (five every three years) | Jamaica Social Investment Fund |
| | Construction Works for the Upgrading of Community Sports Facilities in parks or green areas (for exercise, volley, basket) | 25 community sports facilities annually | Jamaica Social Investment Fund |
| | New parks or green areas maintenance | Annually | Jamaica Social Investment Fund |
| Shock-responsive social safety net for post-disaster recovery | Increase in The National Disaster Fund | Doubling the current National Disaster Fund | Government of Jamaica. 2019. Ministry of Finance and the Public Service. Re: Post-disaster budget execution guidelines |
| | Rehabilitation works after a natural disaster | $3 million USD every two years for post-disaster rehabilitation | World Bank Group. (2018). Advancing disaster risk finance in Jamaica (Report No. 33089). World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/693501524240613093/advancing-disaster-risk-finance-in-jamaica |
| | Cash grants in response to disaster recovery | $200 USD cash grants to 75,000 families every two years as post-disaster support | World Food Programme & Oxford Policy Management. (2020). Shock-responsive social protection in Latin America and the Caribbean: Jamaica case study. World Food Programme. https://www.wfp.org/publications/shock-responsive-social-protection-latin-america-and-caribbean-jamaica-case-study |
| Strengthen vector-borne disease surveillance programas, housing | Activities to prevent the post-hurricane spread of vector borne diseases | Annual public health campaigns | UN Economic Commission for Latin America and the Caribbean (CEPAL), Subregional Headquarters for the Caribbean. (2011, October 22). An assessment of the economic impact of climate change on the |

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|---|---|---|---|
| conditions and public health infrastructure | | | health sector in Jamaica (LC/CAR/L.316). United Nations Economic Commission for Latin America and the Caribbean. https://repositorio.cepal.org /handle/11362/38600 |
| | Provision of mosquito nets and meshed drum covers | 357 mosquito nets annually from 2025 to 2035. | JM Foundations for Competitiveness & Growth |
| Implement the National Financial Inclusion Strategy | Implementation of the Livelihood Protection Policy (LPP) | Assistance to 18,750 individuals every two years | World Bank Group. (2018). Advancing disaster risk finance in Jamaica (Report No. 33089). World Bank. https://documents.worldbank.org /en/publication/documents-reports/documentdetail/ 693501524240613093/advancing-disaster-risk-finance-in-jamaica |

## E. KLEM-JAM operation

### 1. KLEM-JAM calibration data

KLEM-JAM calibrates on an original ‘hybrid’ input-output table (IOT) tracking the economic flows of year 2021. The table is ‘hybrid’ in the sense that it reconciles national accounting data, mostly from World Bank source, energy balance data as captured by the OSeMOSYS model and enery market price data collected from Jamaican sources, first and foremost the PetroJam (refining costs and fuel prices) and JPSCO (power generation costs and electricity prices) companies.

**Figure A5. Hybrid IOT of the Jamaican economy for the year 2021.**

| Million USD | NON-E | ENERGY | C | G | I | X | |
|---|---|---|---|---|---|---|---|
| NON-E | 11 011 | 216 | 11 629 | 1 991 | 3 531 | 2 390 | **30 770** |
| ENERGY | 1 885 | 891 | 539 | - | - | 329 | **3 644** |
| L | 6 190 | 138 | | | | | |
| K | 5 309 | 391 | | | | | |
| R | 24 | 43 | | | | | |
| M | 4 220 | 1 532 | | | | | |
| SM | - | 222 | NON-E | | | | |
| | - | -462 | ENERGY | | | | |
| | - | 309 | C | | | | |
| | - | -70 | X | | | | |
| SALES T | 2 130 | 165 | | | | | |
| EXCISE IC | - | 248 | | | | | |
| EXCISE FC | - | 20 | | | | | |
| | **30 770** | **3 644** | | | | | |

The resulting IOT organises as follows (Figure A5). On the side of resources (columns), the supply of non-energy goods and services (Non-E) or of energy goods (E) requires intermediate consumptions (non-E and E inputs), labour costs (L), capital costs (K), natural resource rents (R), imports (M), specific margins (SM) on sales to domestic agents and on export flows, net sales taxes on products (SALES T) as well as excise taxes on intermediate consumptions (EXCISE IC) and on final consumptions (EXCISE FC).

On the side of uses (rows), imported or domestically produced goods and services contribute to non-E and E productions, are consumed by households (C) and public administration (G), immobilised through investment (I) or exported (X).

For energy, correspondence with the aggregates of the energy balance as captured by the OSeMOSYS model is as follows: the energy consumption by the non-energy sector corresponds to total final energy consumption net of household consumption, which aggregates energy consumption by the residential sector and a share of energy consumption for transport (that whose expenditure is directly made by households). Energy consumption in the energy sector consists of all commercial flows between energy firms. By national accounting convention, government consumption of energy goods is nil. The energy consumption of public administrations is in fact recorded as that of a sector producing public services, of which government is the (almost) exclusive consumer. In the IOT, they are therefore included in the energy consumption of non-E production. Investment in energy goods is also nil once inventory changes have been cancelled out. Exports (X) and imports (M) are close in scope to their counterparts in volume in the energy balance.

The price of each energy use is specific thanks to the specific margins (SM). Importantly, the volume of energy production that balances domestic consumption and net trade is a mixture of primary and transformed energy. This double counting, from the point of view of the energy engineer, is a standard feature of the national accounting framework. Besides, it only covers commercial flows. Traditional biomass and decentralised power production, e.g. the electricity produced by off-grid solar photovoltaics, are not the object of any commercial transaction. KLEM therefore models energy scenarios with increasing off-grid energy systems as scenarios with decreasing energy consumptions and expenses. The capital costs allowing the decreases is endogenously computed by the production function of the non-energy sector for firms but remains implicit in the case of households for lack of sectoral disaggregation.

## 2. KLEM-JAM implementation data and assumptions

Beside the above hybrid IOT dataset, KLEM-JAM implementation requires settling on a set of six elasticities ruling (1) the substitution between inputs in ‘non-energy’ production of non-energy (3 elasticities) and between the Jamaican and international varieties of non-energy goods and services (import and export elasticities), and (2) the correlation between the average real wage and the rate of unemployment on the labour market (1 elasticity of the ‘wage curve’ specification). For lack of Jamaican estimates, or indeed of data allowing estimation, values were taken from the literature. One additional exogenous assumption necessary to the model regards the depreciation rate. That was set constant at 4% following the practice of the recognized Global Trade Analysis Project of Purdue university.

Then the choice of setting up KLEM-JAM as closing *à la* Johansen requires assumptions regarding the dynamics of investment and the trade balance from the calibration year (2021) to the projection horizon (2050).

Trade balance data is available for Jamaica from the World Bank World Development Indicators (WDI) database up to 2023. The data was used as model constraint in the form of GDP share (Equation 14 of the KLEM user guide’s Annex) for the years 2021 to 2023 (2021 data was also used to build up the 2021 hybrid IOT, see above section a.). After 2023, the trade balance contribution to GDP was constrained to converge to its 1990-2023 average in 2060, through spline interpolation. This rule of thumb was applied to both the BAU and LTS scenarios. The consequence is that the two scenarios produce identical trade balance trajectories, as GDP shares, from 2021 to 2060. To do so, they endogenously adjust the ‘real effective exchange rate’ (REER, in KLEM models the ratio of the consumer price index to the import price index) of the Jamaican economy and this is where they diverge. Typically, the LTS scenario, because it envisions rising cuts of energy imports compared to BAU, allows for a higher REER trajectory, which eventually benefits the purchasing power of households hence general activity. Importantly, the 1990-2023 average trade balance to GDP ratio is a substantial 14.6% deficit. The assumed persistence of that deficit induces the implicit assumption that the financial transfers that compensate it in the Balance of Payments, typically remittances from the global Jamaican diaspora, equally persist.

Investment data is regretfully not available for Jamaica beyond 2019 in WDI or national statistics. Facing this lack of information, the 2019 investment effort measured as GDP share was assumed to prevail in 2021 and 2022, then was set at its 2000-2019 average (23.5% of GDP) in 2023 and throughout the projection horizon in the case of the BAU scenario. The LTS investment effort derives from this same assumption but is increased with 50% of the investment requirements specific to the scenario compared with BAU. The investment effort constraint takes the form of Equation 10b of the KLEM user guide Annex.

Yet another macroeconomic assumption necessary to run KLEM-JAM is the share of GDP devoted to direct public expenditure. Like the investment effort, direct public expenditure data are only available up to 2019 in the WDI database. In BAU, we maintain their GDP share at the 2019 registered ratio of 13.6% up to 2022, drop it to 12.2% in 2023 (for the sake of more palatable macroeconomic balances in that year), let it converge to its 1990-2023 average in 2035, and maintain it at that average value up to 2050. In LTS, the surmised GDP share trajectory is augmented with the substantial flow of public expenses backing adaptation measures as estimated by OSeMOSYS modelling. These constraints enter KLEM-JAM through Equation 8 of the KLEM user guide Annex.

On top of the above assumptions, modelling of the BAU with KLEM-JAM mobilises distinctive features of the KLEM model. Firstly, dynamic calibration is performed to warrant that BAU reproduces observed GDP, unemployment and REER data in 2022 and 2023 through adjustments of the productivities of labour and capital, of the real wage/unemployment correlation and of trade (see section 5.5 of the KLEM user guide). This is done factoring in energy efficiency gains that cancel out the capital and labour costs of any decoupling trend between the energy consumption of non-energy firms and potential growth. The reason for factoring in such trend is that OSeMOSYS is not identifying any specific investment on the side of energy demand to explain the efficiency gain. So KLEM-JAM aligns.

Secondly, when running the BAU scenario the model is extended to labour productivity and export trend adjustments to constrain it to GDP and unemployment targets. The purpose is to align the BAU on the GDP growth scenario underlying OSeMOSYS modelling, while guaranteeing a stabilized unemployment trajectory. The two assumptions are thus made part of the definition of BAU. The labour productivity and export trend adjustments that flow from this procedure are then maintained when running the LTS scenario, while both GDP and unemployment are restored as endogenous (unconstrained) variables. The macroeconomic results of the two scenarios should be interpreted in light of that take: BAU GDP and unemployment are constrained at the reported levels while LTS GDP and unemployment are rightly endogenous. The gaps between the two scenarios are the true results of the KLEM-JAM modelling.

# F. Stakeholder engagement

## 1. Approach for the first national workshop

The first national workshop focused on solidifying and reaching consensus on key elements of the cost-benefit analysis. It centered on refining the XLRM matrix for the analysis. Therefore, the workshop prioritized identifying which costs, benefits, and uncertainties are most important to stakeholders and sectoral objectives, as well as determining the best way to measure and obtain that data for Jamaica. This was done by identifying and inviting local stakeholders that are key for policy implementation in the sectors considered in the LTS. Sectors and stakeholders were divided into two workshop days.

Given the differences between adaptation and mitigation, these two groups of strategies are structured differently in the LTS. Mitigation chapters focus on mostly quantitative actions with specific targets, while adaptation chapters outline broader goals that require further clarification for modeling. With these differences in mind, the workshop was designed to gather the necessary data to model actions as effectively as possible for Jamaica, using different group activities for mitigation and adaptation.

**Approach for mitigation:** Each day, participants were provided with a draft XLRM matrix for the relevant sectors being discussed. With this matrix in mind, they were asked to identify which costs, benefits, and uncertainties should be retained, added, or removed from the matrix. Additionally, the consulting team had previously identified key areas where data was missing to complete the model. Therefore, the discussion also focused on identifying documents, contacts, or institutions that might provide useful inputs. Bilateral meetings will be held to follow up on these data and assumption requirements.

**Approach for adaptation:** For each day, the consulting team identified the key actions corresponding to each relevant sector. For each action, participants were asked to discuss the associated costs, benefits, and activities, as well as relevant sources or contacts that could guide the consulting team. Attendees were also asked about the activities to clarify how the actions or goals in the LTS relate to more specific sectoral actions and programs. This step aimed to provide insight into how to quantify the costs and benefits of the various qualitative guidelines and actions outlined in the LTS.

Among both days, the workshop gathered 36 stakeholders, experts in their corresponding fields.

(a) (b) (c) (d)

**Figure A6: Pictures of: (a) the First Workshop's Day 1 participants, (b) Day 2 participants and (c-d) activities carried out.**

## 2. Approach for the second national workshop

For the second workshop, we focused on two key activities. Based on our experience from the first session, we decided to condense the format into a single-day workshop to maximize attendance and foster more dynamic cross-sector discussions. The first activity centered on identifying and validating the assumptions underlying the actions outlined in LTS. Since not all actions included specific targets or were easily quantifiable, we developed tables for participants to review and refine considered targets and clarify the actions under consideration for analysis. While this exercise placed particular emphasis on adaptation measures, it also opened the door to key mitigation-related questions—such as the scale of energy storage deployment and the extent of modal shifts envisioned in the transport sector.

The second activity was designed to address data gaps across the various sectoral models. To facilitate this, the consulting team prepared a targeted list of questions aimed at eliciting information to fill specific data needs for each model. Participants went through the questions at their tables, contributing insights and identifying relevant data sources. Each group engaged in collaborative discussion to formulate responses, and at the conclusion of the activity, each table shared their reflections and key takeaways with the full group. This interactive format helped ensure broad input and alignment across sectors.

(a)

(b)

**Figure A7: Pictures of: (a) the Second Workshop participants and (b) activities carried out.**

The table in the next page summaries the institutions that participated in the first two workshops and bilateral meetings.

## 3. Approach for the presentation of results and capacity building

The near-final results were presented during the Climate Change Branch's post-COP event. The consulting team was given a time slot to present the findings and respond to questions to participants.

Additionally, the team carried out capacity building sessions on the OSeMOSYS and KLEM models. For each model, we carried out two virtual sessions and an in-person session. Here, participants learned about the fundamentals of each model. The in-person capacity-building sessions on OSeMOSYS and KLEM on 27th March, 2025 were well-attended with 24 participants from various institutions. Amongst these, there were students from The University of the West Indies and the University of Technology. Between the in-person and virtual sessions there were also participants from the Ministry of Agriculture, Fisheries and Mining, Forestry Department, Jamaica Bauxite Institute, Ministry of Finance, National Solid Waste Management Authority, Planning Institute of Jamaica, CEMEX and Jamaica Public Service.

| List of consulted entities during LTS CBA development | First workshop | Second workshop | Bilateral meeting |
|---|---|---|---|
| Ministry of Health & Wellness, Jamaica | x | | |
| National Environment & Planning Agency | x | x | x |
| Bureau of Standards Jamaica | x | | |
| Planning Institute of Jamaica | x | x | |
| UTech Jamaica | x | x | |
| Water Resources Authority | x | x | x |
| National Works Agency | x | x | |
| Rural Agricultural Development Authority | x | | |
| Forestry Department | x | x | x |
| Office of Disaster Preparedness and Emergency Management | x | x | |
| Development Bank of Jamaica | x | x | |
| National Conservation Trust Fund | x | | |
| Met Service | x | | |
| Econ. Department UWI-Mona | x | | |
| Caribbean Agriculture Research and Dev. Institute | x | x | |
| Ministry of Agriculture, Fisheries and Mining | x | | |
| CEMEX | x | x | |
| Statistical Institute of Jamaica | x | x | |
| Ministry of Culture, Gender, Entertainment and Sport | x | | x |
| Jamaica Public Service | | x | x |
| Kingston and St. Andrew Municipal Corporation | x | x | |
| National Water Commission | | x | |
| Urban Development Corporation | | x | |
| Ministry of Local Government & Community Development | | x | |
| Jamaica National Heritage Trust | | x | |
| Jamaica Bauxite Institute | | x | |
| National Solid Waste Management Authority | | x | |
| Office Of Utilities Regulation | | x | |
| Jamaica Environment Trust | x | | |
| Ministry of Finance | | | x |

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