

Annex A(4)

Analytical Evidence to Support Guyana's Green State Development Strategy: Vision 2040

Transition to Renewable and Clean Energy

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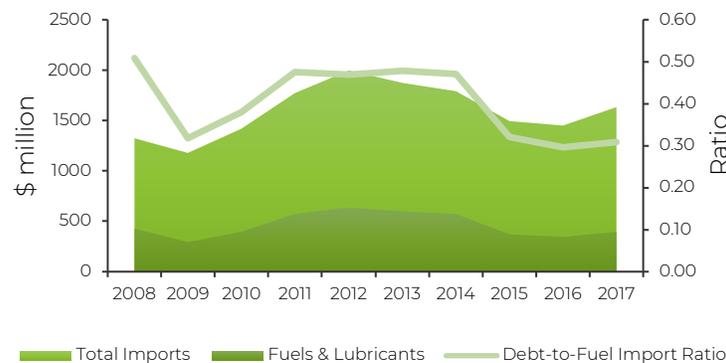
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A 4 Transition to Renewable and Clean Energy

A4.1 Introduction

Guyana is historically, and still is, the most fuel import-reliant economy in the Caribbean region, importing 92% of its energy needs. Averaging about one-third between 2008 and 2017, petroleum products constitute a significant percentage of import bills (Figure 1). The power and transport sectors, which are all oil-based continue to receive the lion's share in total end-use consumption at 70%. Approaching this from a demand-side management perspective suggests that the power and transport sectors are where high impact interventions can be made to significantly lower net petroleum imports.

Figure 1: Petroleum Products as Percentage of Import Bills



Data source: Bank of Guyana Statistical Bulletin, December 2017

The fragility of the petroleum supply has in recent years been affected by a combination of external political and regulatory factors. Over a six-year period, until the Petrocaribe Agreement unilaterally ended in November 2016, the country gained preferential access to oil purchases at concessional prices in exchange for rice as partial payments.¹ As a result, rice production rose rapidly in the Essequibo Islands-West Demerara region in terms of both area and yield.² However, following the rapidly deteriorating cross-border territory dispute with Venezuela from its ongoing exploratory offshore oil exploration, Guyana has since turned to Trinidad and Tobago for its domestic oil requirements.

On the external front, Guyana's net dependency on petroleum imports invariably contribute to a further build up on its debt obligations. While Petrocaribe implemented flexible oil payment arrangements and improved rice exports, this somewhat rendered Guyana at risk of debt service default.³ This is in part because, while oil price shocks tend to be transitory, the adjustments necessary to factor in these price shifts in electricity tariffs remained rigid for the

¹ The Petrocaribe Agreement is discussed in detail in subchapter on Macroeconomic Assessment of Diagnostic Study.

² Wenner, M., Rogers, R. and D. Clarke. 2016. Guyana's PetroCaribe Compensation Scheme Has Ended: Assessment and Policy Implications. *Technical Note*. Inter-American Development Bank.

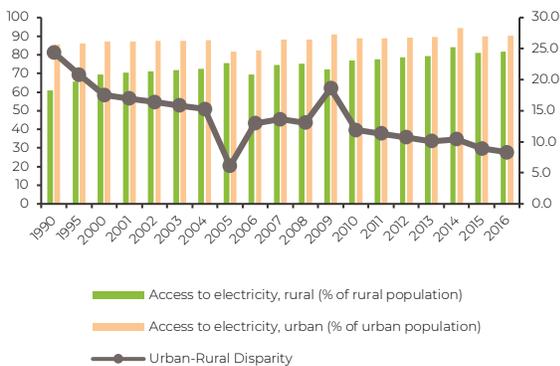
³ Under Petrocaribe Agreement, once payments for rice-equivalent exports are deducted, the remaining 40% of payments can be paid for up to 25-year financing agreement with 1% interest if oil prices are above \$40 per barrel.

most part. These economic circumstances and changing political sentiment over local energy resource development keep the country highly exposed to domestic shocks.

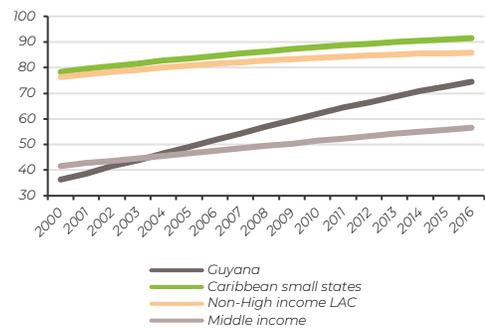
Guyana made commitments to a green economy pathway even as it evolves from a leading oil importer to an exporter. There is a growing impetus for action on energy-related targets such as ensuring access to affordable, reliable, sustainable and modern energy (SDG Goal 7), making cities more sustainable (Goal 11) and ensuring sustainable consumption and production patterns (Goal 12) all of which relate to energy sector development. Figures 2a-e show Guyana's socio-economic development in reference to energy-related SDGs from 1990-2016.

Figures 2a-2e: Demonstrating Guyana's socio-economic development in reference to energy-related SDGs (1990-2016)

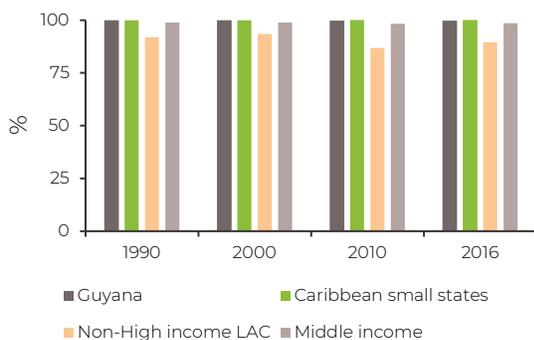
2a: Proportion of Urban & Rural Population with access to electricity (SDG 11: Making cities more sustainable)



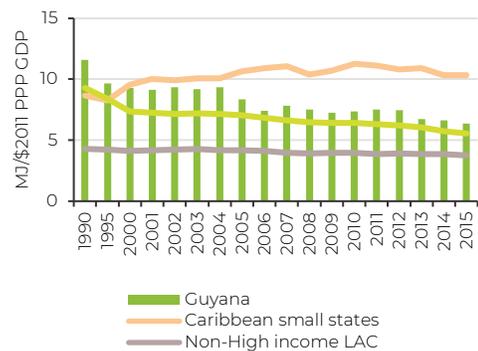
2b: Proportion of Population with primary reliance on clean fuels and technologies for cooking (2000-2016)



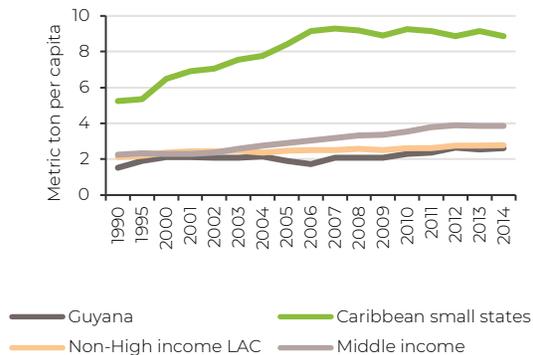
2c: Percent of population exposed to ambient concentrations of PM_{2.5} above the World Health Organisation Guideline (SDG 12: Sustainable Consumption and Production)



2d: Energy intensity (ratio of energy supply and GDP)



2e: Carbon Dioxide Emissions (metric tons per capita)



Currently, electricity access advanced marginally faster in urban than rural areas and as a result, urban-rural gaps have narrowed from 24% in 1990 to 8% in 2016 (Figure 2a). At the national level, an increasing proportion of the Guyanese population have gained access to electricity from 68% in 1990 to 84% in 2016, but 0.122 million still live without it; this is well below the regional average, both for Caribbean and middle-income states.

Approximately one-quarter of the population still relies on traditional fuel sources for cooking (Figure 2b). Exposure to household air pollution, which largely comes from indoor cooking stove fuels, is one of the highest environmental health risks according to the World Health Organisation (WHO) (2014).⁴ Across the country, recent estimates suggest that average annual exposure to ambient particulate matter of 2.5 microns (PM_{2.5}) concentration levels, which exceed the WHO's Air Quality Guidelines, has not improved with more than 90% of population remaining exposed (Figure 2c). When this economic externality is translated in health terms, for instance, Guyana's ambient air pollution was responsible for almost 300 mortality in 2016.⁵ It can be noted that the burden of disease associated with air pollution generally tends to put pressure on the public health system, with the Government typically bearing a significant cost for healthcare. Thus, the necessary level of intervention in the energy sector should go beyond stabilising the fuel market. There is a need to ensure that Guyanese consumers receive or have access to superior quality fuels for all uses. However, this is complicated by the fact that there is (so far) no national fuel quality standard to ensure appropriate market fuel quality and verification system in place for fuel integrity testing in non-transport uses.

Guyana's energy intensity improved by almost half, from 11.6 megajoules per unit of GDP (2011 \$ PPP) in 1990 to 6.4 in 2015, generally well below other Caribbean small states (Figure 2d). Carbon dioxide (CO₂) emissions per capita have recently increased to 2.63 from 1.52, largely because of greater petroleum use outpacing population growth, particularly in the energy sector (Figure 2e). The country could be at risk of increasing CO₂ emissions from the anticipated petroleum boom particularly in downstream markets.

⁴ World Health Organisation. 2014. Ambient and Household Air Pollution and Health Update 2014.

⁵ Statista. 2018. The Statistics Portal Database. <https://www.statista.com/statistics/868830/number-deaths-ambient-air-pollution-guyana/> [Accessed 30 July 2018]

The Government recognises that a well-managed energy sector is pivotal for economic growth, and the sector continues to play an important role in achieving its broader development objectives over the longer term. The use of associated natural gas and renewable sources for electricity production may partly ease domestic fuel consumption. This can be further complemented with green economy interventions to reinforce the phasing in of vehicle fuel economy standards or building energy codes. Implementing strong local content requirements that emphasise sustainability, particularly for material and resource use, will in addition support the wider ambition for economic transformation.

A4.2 Energy Consumption

A4.2.1 STRUCTURE OF FINAL ENERGY USE

The primary local energy source in Guyana, as in many developing countries, is biomass in the form of firewood and other primary sources including self-generating from solar sources and rice husks. However, in terms of final energy use, demand for biomass is lowest, at 3% and limited to households and industry sectors. This trend – small use of biomass for cooking that is offset by modern though not necessarily cleaner fuels (electricity, LPG, kerosene) – should be expected as per capita discretionary incomes continue to improve, with Guyana's shift to a more urbanised and industrialised setting. Bagasse accounted for 17%, petroleum products for 70%, and electricity for 10% (Figures 3a-b). Efficiency losses accounted for about 22%, at 203.4 kiloton of oil-equivalent (ktoe), and these come from petroleum used for power plants and self-generating users, bagasse and other primary sources which are either lost or used up during intermediate transformation of energy.

Figures 3a-b: Primary Energy Supply and Demand by Source, 2016

Figure 3a: Supply

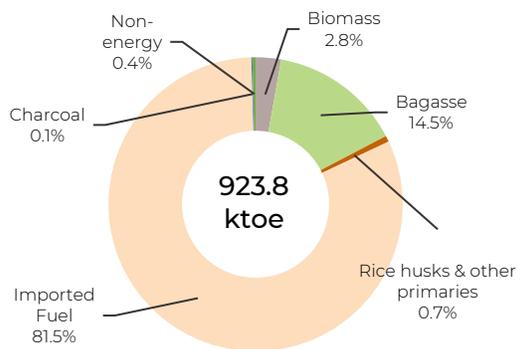
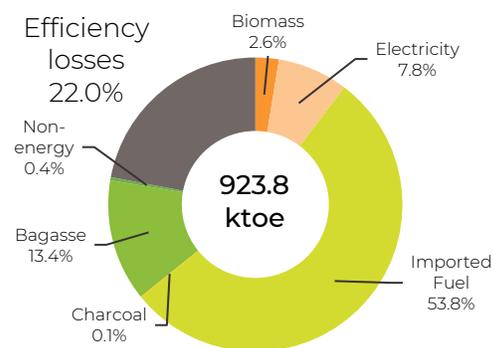


Figure 3b: Demand



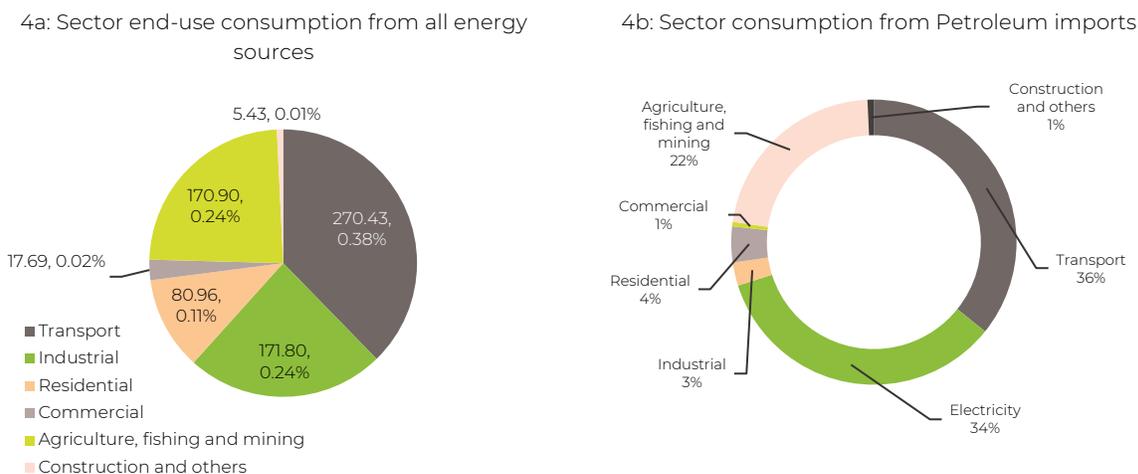
Adapted from original data source: Guyana Energy Agency, 2018

A4.2.2 SECTOR ENERGY USE

In 2016, total energy consumption was 717 ktoe (Figure 4a). The transport sector accounted for 38% of total energy consumption, the industrial sector for 24%, agriculture, fisheries and mining for 24%, households for 11%, and commercial and construction sectors for 3%. This reflects the relatively low level of commercial and construction activity. Also, the high share accounted for by the transport sector reflects its reliance on petroleum products at 36% (Figure 4b). Electricity accounted for 34% of petroleum imports, which comprise about 96% of

total fuel oil and 19% of total diesel. The use of fuel oil, particularly heavy fuel oil, which has high efficiency for generating power, produces higher emissions of pollutants (which in turn has implications for health). Agriculture and mining consumed 43% of total kerosene products. Households are the highest consumer of liquefied petroleum gas (LPG) for hot water and cooking. All petroleum fuels are imported.

Figures 4a-b: Energy consumption by Sector (in ktoe), 2016



Note: Figure 4a reflects sector shares based on total value of 717ktoe (excludes efficiency loss values of 203.4ktoe). Figure 4b reflects end-use sector and electricity shares based on total petroleum imports of 755.9ktoe.

Adapted from original data source: Guyana Energy Agency, 2018.

A4.3 Energy Resources

Guyana has known deposits of oil and gas along its offshore territory. It has no known coal deposits except for some peat scattered in the Demerara area.⁶ There are abundant renewable energy resources such as biomass, biogas, hydro, and solar, and a potential for wind energy in some parts including the coastal regions. Total primary energy supply stood at 923.8 ktoe in 2016 and is expected to substantially increase owing to resource exploration efforts, production-sharing contracts and licensing rounds as implied by a continued surge of upstream oil and gas investment.

A4.3.1 OIL AND GAS

The first successful appraisal of commercially feasible deposits at the Liza field was made in May 2015, with subsequent discoveries in the Ranger, Pacora and Longtail fields made in 2018. In 2016, the Government signed the declaration of commerciality of the venture. Although commercial appraisals took place only recently, exploration efforts started as early as the 1900s. According to records from the Guyana Geology and Mines Commission (GGMC), exploration activity started in 1916 with three exploration wells drilled in Barima-Waini (Region 1). This resulted with gas and pitch found in one of the wells. In 1926, exploration wells at the

⁶ According to a U.S. Geological Survey that was conducted by Weaver and Gordon (1993) - Weaver, J. and G. Wood. 1993. Coal Map of South America: U.S. Geological Survey. U.S. Department of Interior. <https://pubs.usgs.gov/coal/145/report.pdf> [Accessed: 30 July 2018].

Bath Sugar Estate in Berbice produced enough gas for domestic use. The California Oil Company subsequently undertook offshore explorations in 1958, was suspended two years later, but sparked interest in the country as more companies were awarded licenses for exploration. Between 1966 and 1967, Shell company invested in drilling six wells along the Atlantic coast at Drill, Mahaicony (Mahaica-Berbice), Berbice River, Corentyne River and Skeldon area (East Berbice-Corentyne). By 1967, Teneco was the first company to spud the well. In 2008, Exxon Mobil and its affiliates (Esso Exploration and Production Guyana Ltd. [EEPGL], Hess and China National Offshore Oil Corporation [CNOOC]) started exploration of the 6.6 million acre Stabroek Block at the Essequibo region and drilled offshore wells up to 5,512 metres in depth in 2,030 metres of water. Results from seismic data, geologic and well analyses revealed multiple oil discoveries.^{7,8}

The potential of the oil industry in Guyana was only fully recognised in 2015 with ExxonMobil and EEPGL discovering over 90 meters of oil-bearing sandstone reservoir in the Liza 1 well in the Stabroek Block. This was followed by efforts on Liza-2 well in July 2016 and Liza-3 well that discovered over one billion oil-equivalent barrels, confirming the Stabroek Block as a world-class oil resource. Due to the success of Liza Phase 1 development in 2015, several other oil and gas companies (representing France, Canada, United Kingdom, Spain, to name a few) now hold petroleum prospecting licenses. Petroleum drilling activities are focused on eight blocks, namely: each operated by an international company and their local affiliates. As of 2018, eleven companies hold shares in these blocks.⁹

Table 1: Oil Companies Operating in Guyana's Offshore Oil Exploration Blocks

Exploration Block	Block Details	Operators
Roraima Block	19828 km ²	Anadarko Petroleum Corporation
Kaieteur Block	13,535 km ² , 250 offshore	Ratio Oil/Esso Exploration & Petroleum Limited Guyana
Stabroek Block	26,800 km ² ; 193 km offshore	Esso Exploration & Petroleum Limited Guyana/CNOOC Nexen Guyana Limited/HESS Corporation
Canje Block	6021 km ² , 190- 300km offshore	Esso Exploration & Petroleum Limited Guyana/Mid-Atlantic/JHI Associates Inc.
Demerara Block	4000 km ²	CGX Guyana
Kanuku Block	6525 km ²	Repsol/Tullow Oil
Corentyne Block	6200 km ²	CGX Energy
Orindiuk Block	1,8000 km ²	Tullow Oil, Eco-Atlantic

Source: <https://gyeiti.org/oil-gas-contracts/>

⁷ Guyana history with oil dates back centuries (2017, September 24). *OilNow*. Retrieved from <http://oilnow.gy>

⁸ Ince-Carvalho, L. 2017. "Out Front: Exxon Mobil is leading the exploration of a whole new industry". March. *8th Edition Business Guyana*. The Promise of Oil. Georgetown Chamber of Commerce. March.

⁹ Tables 1 and 2 of Appendix 2 provide additional details of timeline for exploration activities at the Stabroek Block and list of companies with petroleum prospecting and production licenses respectively.

In 2016, the Government has so far granted only one production contract to undertake commercial production during Liza Phase 1 development. The Production Sharing Agreement (PSA) will have a floating production storage and offloading (FPSO) vessel with a maximum capacity of 120,000 oil-equivalent barrels per day, or equivalent to 43.8 million oil-barrel equivalents per year. This includes possible additional production during Liza Phases 2 and 3. An increase in daily production of 220,000 oil-equivalent barrels can be expected in Phase 2 by mid-2022 and a further increase of 180,000 oil-equivalent barrels can be expected in Phase 3 starting 2023. Considering maximum daily productions under the PSA (guaranteed production) and petroleum prospecting licenses (exploration), about 3.6 billion oil-equivalent barrels could be available between 2020 and 2040 under the Liza Phase 1-3 developments (Figure 5). More recent appraisals in exploration work suggest up to 4 billion recoverable oil-equivalent barrels.

Figure 5: Oil Projections for Liza Development



Note: Phase 2E and Phase 3E are estimated daily production of 220,000 and 180,000 oil-equivalent barrels based on petroleum prospecting licenses

Adapted from original data source: Ministry of Natural Resources

From all indications, the Government's top priority is to quantify petroleum and gas reserves with reasonable certainty. Increasing the relative certainty in reserve projections is particularly critical in connection with a national depletion policy for hydrocarbon, which the Government is considering. In this context, Malaysia was one of the first oil-producing countries to introduce a depletion policy that was subsequently supplemented by a fuel diversification policy in 1981 (the fuel diversification policy was updated to include renewable energy in 2000). Both policies are meant to be implemented hand-in-hand to ensure reliability and security of energy supply.¹⁰ In the case of Guyana, a depletion policy will help address common concerns about resource curse. A fuel diversification policy may specifically focus on oil, natural gas, biofuel, and renewable energy. These two policies could be introduced to support the broader

¹⁰ Jalal, T. and P. Bodger. 2009. National Energy Policies and the Electricity Sector in Malaysia. *Proceedings of ICEE 2009 3rd International Conference on Energy and Environment, 7-9 December 2009, Malacca, Malaysia*. [Derived from Ministry of Energy. 2005. *Water and Communications: Energy Policies of Malaysia*.]

objectives and implementation of the 2016 overall energy policy (forthcoming) and 1998 Petroleum Law; although the latter may now require revisiting and updating.

There is still some ambiguity in oil revenues and therefore a general tendency to be speculative particularly with respect to the Fund's governance structure and benchmarking as set out under the Santiago Principles.¹¹ In terms of capping arrangements for the Fund, countries have used different capping requirements, for example, Ghana employs a 21% for its stabilisation fund and 9% for its heritage or savings fund. In terms of its stabilisation component, it could be used for smoothing fiscal expenditures although this requires careful effort due to possibility of frontloading. Its use for debt payments will also require some economic logic of borrowing, particularly in terms of reviewing the level of interest rate payments. If designed and implemented properly, the stabilisation component will help to address foreign exchange fluctuations, which in turn partly addresses the concerns of dutch disease. A third component of revenues is expected to be earmarked for financing infrastructure investments including energy. The design and mechanism for accessing revenues are currently being developed and is expected to be laid in the Parliament at the end of 2018.

It is understood that oil revenues will be lodged in a special account in the general fund and cash will be available when needed, depending on the rules on access to the Fund. Guyana can learn from other oil producing developing countries in this regard. For example, the Malampaya Gas and Oil Fund of the Philippines has, to some extent, a similar arrangement with a statutory budget structure. One weakness of the Malampaya Fund is that while revenues are under a special fund to finance energy development projects, withdrawal for other purposes may be allowed and approved by the President without legislative sanction. The possibility that Guyana's Sovereign Wealth Fund may be misappropriated, regardless of good design, can be avoided by ensuring that use of funds for other purposes is guided by clauses for legislative sanction.

Resolving the ongoing border dispute with Venezuela, which is largely an inherent risk, will require a strategic resolution to improve the valuation of resource rents in future PSAs. The royalty fee under the current PSA is 2%, which is lower than average resource rents of 5%-6% for petroleum.

A4.3.2 ASSOCIATED NATURAL GAS

The negative impacts of gas flaring are well understood by the Government. According to the Ministry of Natural Resources, Guyana will not undertake routine gas flaring for any excess associated gas produced from the offshore petroleum fields.¹² The option to release gas to the atmosphere by flaring and venting is an important practice in oil production for safety reasons. However, it generates a high level of hydrocarbons when oil-gas-water solutions are flared. The process of burning associated gas has many negative impacts to the environment, including the release of CO₂, methane, and other greenhouse gas emissions. For instance, studies in

¹¹ About \$460.24 million in pre-contract costs in connection with petroleum operations under the 1999 Petroleum Agreement, and prior to 2015, will be recovered in addition to costs incurred during production phase.

¹² Ministry of Natural Resources. (2018, July 13). *Meeting with the Minister on Green State Development Strategy*. Georgetown, Guyana.

Nigeria, where gas flaring is not prohibited, demonstrated the links between environmental impacts such as acid rain due to SO₂ and NO released from burning natural gas. Other impacts include soil contamination and negative health impacts due to exposure to pollutants.^{13,14} Globally, the annual volume of associated gas being flared and vented is estimated at about 110 billion cubic meters according to a World Bank report (2011).¹⁵

Instead of flaring, a pipeline infrastructure from the offshore production site to the nearest shore landing is being planned for construction. The Government plans to use associated gas for electricity generation but there is still uncertainty particularly in terms of converting gas to power, some of which are being planned for a proposed 180-200 MW natural gas plant of bi-fuel capacity by 2025 according to the Ministry of Natural Resources. Construction of a 50 MW natural gas plant is also being considered according to GPL. This implies that Guyana's planned gas-to-power project is expected to provide benefits in many ways, among which is reducing oil imports, assuring a more stable supply of energy (to encourage companies who are self-producing back to national grid), a cleaner source of power and meeting more than 100% of energy requirements.

Meanwhile the Multi-Stakeholder Expert Group on Energy Transition contend that, and as implied in the recommended power supply mix, all existing heavy fuel oils (HFOs) generating sets will either be decommissioned or converted into dual fuel operations, starting with 8.7 MW by 2019 and a further 170 MW by 2025.¹⁶ It is less realistic to assume that natural gas will be made available by 2019; initial production is planned between 2022 and 2025. According to GPL, conversion of existing units may not be economical due to distance from gas, age of units and direct costs associated with conversions and upgrades.

Secondary use of associated gas will be as a transport fuel. The liquid component is being planned for liquefied petroleum gas (LPG), although processing will largely depend on an available onsite oil refinery. Currently, imported LPG is not being used in transport, and only by households (90%) and in commercial and industrial sectors (10%). Compressed Natural Gas (CNG) is another possibility, which if made available in domestic market, could allow conversion and retrofits of existing vehicles from gasoline to CNG.

Government has identified a landing site, and technical assessments are being carried out to determine the feasibility of getting the gas piped from well areas located about 100 miles from shore, and the required power system structure for converting it to power.

A4.4 Power

A4.4.1 GENERATION

Guyana Power & Light Inc. (GPL)'s own generating capacity is almost 100% fuel based. As of December 2017, the national grid or the Demerara Berbice Interconnection System (DBIS) has

¹³ Saheed Ismail, O. and G. Umukoro. 2012. Global Impact of Gas Flaring. *Journal of Energy and Power Engineering*. 4: 290-302.

¹⁴ Ajugwo, AO. 2013. Negative Effects of Gas Flaring: The Nigerian Experience. *Journal of Environment Pollution and Human Health*. 1.1: 6-8.

¹⁵ World Bank. 2011. Gas Flaring Reductions Avoid 30 Million Tons of Carbon Dioxide Emissions in 2010. World Bank Press Release. Washington D.C.

¹⁶ This is discussed in detail in the GSDS Strategy Document, "Transitioning to Renewable and Clean Energy" Chapter.

167 MW of total installed capacity from 7 existing power plants and some isolated systems in Bartica and Anna Regina (GPL 2017).¹⁷ Only 135.9 MW units are effective and operating. GPL's own generation is insufficient for supplying the domestic market hence it buys power from one domestic independent power producer (IPP), GUYSUCO.

The generation system comprises relatively new medium-speed diesel units fueled by heavy fuel oil and with installed capacity of 126 MW that includes 10MW from an Independent Power Producer (IPP). About 40.7 MW are being generated from old high-speed engines fueled by light fuel oil but these are in need of replacement (25.1 MW is operational). Actual DBIS peak demand is 110 MW. Some of the self-generating sources from diesel-operated generators and solar PV are also present, at about 42 MW. GPL is examining renewable energy proposals from possible Independent Power Producers (IPPs).

Currently, there is a lack of redundancy in the grid. This means that there is no guarantee of a reliable power switchover to auxiliary power in case of generator shutdown or loss of power. GPL owns all utility systems but the operations and maintenance of generating plants is completely outsourced to an international company (Wartsila). A local government entity will soon take over its operations and maintenance.

A4.4.2 TRANSMISSION

GPL is responsible for planning, implementing and managing the Interconnected System: generating stations, transformers, transmission and distribution lines, secondary mains, service lines and the consumers, that make up the National Grid. Currently, the transmission system primarily operates using 69 kilovolt (kV) lines and this network is used to transfer electric energy to load centers for utilisation of customers that are connected to the national grid. In total, there are now 276 kilometers (km) of 69kV transmission lines. The transmission and distribution network include thirteen (13) 69/13.8kV substations and a new 69kV Sophia switching substation. The transmission is concentrated in the coastal region, which serves the Georgetown capital and Berbice. Presently, Guyana has no cross-border connections for importing electricity.

In addition to GPL's network, the Hinterland Electrification Incorporated (HECI) operates six grids, supplied with diesel and HFO generators. DBIS is not yet interconnected with other grids, and the Linden interconnection with DBIS is being considered in 2021. The DBIS or central grid tariffs are higher than the Linden Network and consolidating tariffs between the two creates another challenge for GPL.

GPL is investing \$18.06 million to construct 83 kilometers (km) of single circuit 69 kV lines, with 47 km to be completed in 2019 (Table 2). On distribution, the company will be upgrading 92 km of medium voltage (MV) and Low voltage (LV) distribution networks amounting to \$22.4 million. This is part of the transmission and distribution expansion and 10 modernisation plan. An additional 322 km of 230 kV transmission lines are planned between 2020 and 2025 and 395 km 500 kV by 2025 to support the cross-border trade to Suriname and Brazil.

¹⁷ Guyana Power & Light Inc. 2017. Development and Expansion Programme 2017-2021.

Table 2: Transmission Line Network (69 kilovolt)

Location	Transmission line length	Status
Kingston and Sophia	6	80% complete
Sophia and Good Hope	10	Planned
Good Hope and Columbia	26	Planned
Vreed En Hoop and Wales West Bank Demerara	11	80% complete
Edinburgh and Hydronie East Bank Berbice	18	80% complete
Garden of Eden and Kuru Kuru East Bank Demerara	12	80% complete
Total	83	

Note: ckm= circuit kilometer length

Source: Guyana Power & Light Inc. 2017. Development and Expansion Programme 2017 – 2021

In 2016, GPL had high technical and commercial losses (theft) at 30.6% and 28.6% respectively (Table 3). This is a clear indication that fuel is being burned and consumers bear such losses. Table 3 shows actual and projected reduction in power losses as a result of planned interventions. To address non-technical losses, an investment of \$36.6 million is allocated to install 92,300 AMI meters with new service lines and associated materials. To minimise incidence of theft, regular inspection of areas and reinforced networks to reduce illegal connections will be installed. GPL is also encouraged to prosecute all cases of illegal electricity extraction. In addition, a social management programme will be launched to educate consumers on the impacts of electricity theft.

Table 3: Target Improvements in Power Losses, 2015-2020

	2015	2016	2017	2018	2019	2020
Technical	14.28	13.10	12.90	12.60	12.60	23.30
Commercial/Economic	16.32	15.50	14.70	14.00	13.10	12.30
Overall	30.6	28.6	27.6	26.6	25.7	11.00

Source: Guyana Power & Light Inc. 2017. Development and Expansion Programme 2017 – 2021.

A4.4.3 DISTRIBUTION

GPL has a de facto monopoly on the distribution of electricity in Guyana, and manages the distribution services and networks. The power distribution function involves planning, expanding, operating, maintaining, and rehabilitating the power distribution networks, including substations up to the 22 kV level, and providing consumer services such as new connections, meter reading, billing, and revenue collection. At the end of December 2012, GPL had 166,878 customers. By the end of 2017 this increased to a total of 187,855 customers 170,493 of these being residential, 16,515 commercial and 847 industrial. Electricity sold in 2017 amounted to 556 gigawatt hours (GWh) which is equivalent to GY\$32,779,948 million in sales. The residential consumer category made up 91% of consumers in 2017, contributing 35% of

sales. The industrial and commercial consumer categories combined represented about 9% of consumers but accounted for 55% of sales. The remainder is attributed to street lighting and prepaid sales, which are not disaggregated according to consumer type.

A4.4.4 ELECTRICITY ACCESS

Guyana's electrification rate of about 84% is comparable to other countries, although still well below the regional average for Caribbean states.¹⁸ About 90% of the urban population and 81% of the population in rural areas have access to electricity; a remarkable improvement in disparity 24% in 1990 to 9% in 2016.

Of those areas not yet connected to the grid, about 19% of the population rely on off-grid solutions for intermittent power. Approximately 20,000 individual solar units are installed, about half of these units remain non-functional as a result of the batteries becoming inoperable (HECI 2018). Payment collection requires village councils to collect monthly fees of GY\$500 from each homeowner. The village councils are also responsible for basic maintenance including replacement of batteries. However, this arrangement has not been successful. The major problems affecting sustainable hinterland electrification are: (a) low capacity to pay and (b) lack of required technical skills to maintain solar home systems.

As with any developing country of similar fundamentals, high levels of loan defaults and lack of technical skills are common issues in off grid solar homes installation projects. Households tend to have lower purchasing power, and there are limited capacity and technical skills available in the communities. There is also generally low demand for electricity. The same cases are reported in similar projects in Lao People's Democratic Republic. These however were circumvented through a downward revision in loan repayment schedules (i.e. from ten years to five years) and provision of financial incentives to technicians and debt collectors, to name a few. These are some modifications that could be introduced in subsequent phases of hinterland electrification programs.

Mini hydro schemes are also installed in communities particularly those within reasonable proximity from major hinterland areas such as Lethem, Mahdia and Port Kaituma. Some of the hinterland communities also use diesel-powered mini-grids, as well as indigenous sources such as solar, wind, hydro or biofuels. While off grid applications may, in general, be the optimal approach in the interim, these structures will have to be designed in a manner that would allow interconnection and consolidation with other grids in the future (Mohanty, Muneer and Kolhe 2015).¹⁹

A4.4.5 ELECTRICITY TARIFF

The Public Utilities Commission (PUC) approved a downward revision on tariff structure in April 2016 (Table 4). These rates reflect a cumulative reduction of 20% in net rates - comprising 5% reduction on across-the-board charges and an additional 15% fuel rebate on energy charge. The overall effect is a 10% reduction in electricity bills across all user categories, with tariff reductions ranging from GY\$4.48 to GY\$6.74. Households that utilise less than 75 kWh per

¹⁸ IMF Estimates the Caribbean as a 90% electrification rate. McIntyre, Arnold, et al IMF Working Paper WP 16/53: Caribbean Energy – Macro Related Challenges (2016)

¹⁹ Mohanty, P., Muneer, T. and M. Kolhe (Eds.). 2015. Solar Photovoltaic System Applications: A Guidebook for Off-Grid Electrification. Springer.

month can take advantage of a lifeline tariff, at net saving of GY\$4.33 per kWh. According to GPL (2017), the residential sector, under Tariff A, receives a cross-subsidy of 33% from all Government tariffs and Non-government tariffs (B, C, and D).

This structure reflects somewhat a flexible tariff adjustment mechanism that takes into account inflation, changes in petroleum product prices, and exchange rate fluctuations. In principle, this mechanism would have allowed GPL to recover windfall losses, particularly during spikes in global oil prices. However, it is relatively rigid because adjustments in tariff rates are made over a long lag, rather than automatically adjusted or revised in shorter periods of time. For instance, no immediate changes are made since 2016. It is only recently that GPL is reviewing and revising the tariff structure.²⁰ GPL's financial performance, already problematic to start with, has not improved as a result. There is therefore a need to consider introducing an automatic, or more flexible, tariff adjustment mechanism that takes into account ceiling spikes in petroleum product prices at relatively shorter time lags.

Adjusting tariff rates automatically or at shorter time lags are economically logical to pursue, given that the demand for electricity consumption is inelastic to price in the short run than in the long run. In practical terms, this will allow GPL to recover windfall losses during sudden spikes in oil prices, and offset otherwise, without pushing its financial health into free fall. This will also help in easing direct and implicit subsidies for electricity, including those targeted to cover GPL's cost recovery requirements and potential revenue losses. In 2013, the total amount of electricity subsidies including those targeted to recover investment and operational obligations of GPL stood at about 1.3% of GDP.²¹

At the same time, due to the demand elastic nature in the long run, GPL and high energy intensive consumers particularly residential and industries will have more time to identify options and make substantive adjustments in response to changes in energy prices. This includes increasing utility-scale renewable energy capacity, adopting energy-saving measures, and switching to fuel efficient cars and freight trucks, to name a few.

Currently, Guyana does not yet adopt a deregulated system that would allow for a vertically integrated utilities structure. GPL owns the infrastructure for generation (although operations and maintenance services are currently outsourced), and transmission and distribution systems. This structure inherently increases the financial liability of GPL.

GPL must build capacity to implement a more flexible tariff adjustment mechanism, as well as to determine the wheeling charges to recover capital and operating costs for its transmission system, particularly for future IPPs using the GPL transmission system, such as for transporting power into Brazil. Incentives meant to optimise operational costs must be provided as an alternative relief for direct subsidisation of GPL's operations.

²⁰ Initial discussions with GPL suggest a possible additional cost of GY\$ 0.25 per kWh for residential and GY\$0.35 for commercial users. It is currently under review.

²¹ Di Bella, G. Norton, L., Ntamatungiro, J., Ogawa, S. Samake, I. and M. Santoro. 2015. Energy Subsidies in Latin America and the Caribbean: Stocktaking and Policy Challenges. *International Monetary Fund Working Paper no. 30*. [Accessed: <https://www.imf.org/external/pubs/ft/wp/2015/wp1530.pdf>]

Table 4: GPL Tariff Structure

Category	Tariffs	Net Energy Rate GY\$ effective April 1, 2016	Net Energy Rate GY\$ (old rate) as March 1, 2015	Net Energy Rate decrease GY\$
Residential: Lifeline	A <75 kWh	39.10	43.58	4.48
Residential	A >75 kWh	43.43	48.40	4.97
Commercial	B	56.38	62.84	6.46
Industrial	C	50.93	56.76	5.83
Industrial	D	48.78	54.37	5.59
Street Lights	E	43.08	48.02	4.94
Government				
Residential	GA <75 kWh	47.17	52.58	5.41
Residential	GA >75 kWh	47.81	53.29	5.48
Commercial	GB	58.83	65.57	6.74

Source: GPL. 2018. Retrieved from <http://www.gplinc.net/domestic/rates>

A4.5 Renewable Energy and Generation Expansion

Guyana will develop both renewable and clean energy sources to meet domestic energy demand. In this context, the Government classifies natural gas as a cleaner fuel relative to imported petroleum products. Given the country's favourable hydrology, Guyana has between 4,600 MW and 7,600 MW of technically viable power potential in its rivers and tributaries.²² Beyond hydropower, the country has a reasonable level of solar energy density. Owing to its geographic location, there is good potential for export-oriented investments in cross-border power trade particularly to supply power generated from large scale hydropower (generally considered non-renewable if generating capacity is 15 MW and above), natural gas and renewable energy technologies — solar, wind, and bagasse. Renewable energy developers can sign long-term power purchase agreements on a case-by-case basis with the state-owned utility (GPL). Long-term PPAs are also being considered for grid-connected or utility scale solar PV.

GPL has initially imposed a cap of 100 kW peak of installed capacity for self-energy producers. This cap applies to customers who require grid-tied renewable energy. It is an interim cap to ensure that the reliability of the grid is maintained as well as serving as a safety measure. This is because GPL does not yet have any information on the penetration limit for feeders. GPL intends to review the cap to determine appropriate levels once studies have been completed to determine penetration levels.

²² Monenco 1974; IDB forthcoming

A4.5.1 HYDROPOWER POTENTIAL

There is slow development of hydropower development due to changing political sentiment. To wit, the 165 MW Amaila project will no longer be pursued, primarily due to its high construction costs (almost US\$1 billion) and structural issues pertaining to the design of the reservoir with high environmental and social risks.

Hydropower holds significant promise, but it requires a pragmatic approach. Its development presents good potential for use as baseload power in hinterland areas, and for offsetting spikes in demand in coastal areas. However, developing hydropower plants, particularly with reservoirs in rivers or within catchment areas, present challenges for Guyana with its limited capability of taking on long-term financial risks including loan repayment, guarantees in power purchase agreements, and resettlement and compensations. The Government places its priority in developing four 75MW-100MW run-of-the-river modular hydro-plants to supply power in hinterland regions, rather than reservoir structures.²³ Table 5 summarises potential hydropower sites identified between 1957 and 2018, cumulatively amounting to approximately US\$15 million in investments.

Table 5: Summary of proposed hydropower projects

Year	Project	Location	Size (MW)	Cost (\$M)	Status
1957	Tumatumari		1.5, 2.2 (proposed)	N.A.	Private developers now (2018) seeking to recommission
1974	Upper Mazaruni		4,775	N.A.	2012 MOU with Brazil for feasibility studies. ArcoNorte Interconnection study for export of energy to other countries proves feasible
1998 - 2014	Amaila Falls		165	858.0	Abandoned
1999	Moco Moco	Region 9	0.7	2.2	Funding for recommissioning requested from UAE
2018	Ikuribisi	Region 7	1.0	5.22	Funding requested through Guyana REDD Plus Investment Fund (GRIF)
2018	Kumu Falls	Region 9	1.5	6.42	Proposed funding from UAE and GRIF
2018	Kato	Region 8	0.2	0.2	GOG and GIZ Rita funding
2018	Hosororo	Region 1	0.02		Proposed funding from UAE and GRIF

Note: Costs include capital requirements for generation and associated transmission. Repayments and compensations are not included.

Source: Multiple reports from Guyana Energy Agency.

A4.5.2 SOLAR

There is high potential for solar development in Guyana. Daily average solar insolation incident is about 4.1 to 5.5 kWh/m²/day, which is among the highest globally. Initially, the Government has been pursuing solar energy primarily targeted to power off-grid communities. A total of

²³Ministry of Natural Resources. (2018, July 13). *Meeting with the Minister on Green State Development Strategy*. Georgetown, Guyana.

19,700 units of 65 W-rated solar systems are installed in homes and 125 kW for schools and other community buildings in 21 hinterland communities. There are several other private installations of solar PVs in Georgetown, primarily the Demerara Bank and Starr Computers. In terms of commercially available financing, the Guyana Bank for Trade Industry (GBTI) offers a 'Green Loan' for those interested in installing grid-tied solar schemes although, there is not yet a tariff mechanism in place for supplying excess power back to the grid. GPL recently passed a proposal for net billing. Table 6 shows proposed and existing projects on solar sources.

Table 6: Proposed and Existing Solar PV Projects

Project Location	Project Size (MW)	Project Cost (\$)	Funding Source	Status
Bartica	1.5	3.87	IDB	Feasibility
Lethem	1.0	2.6	IDB	In progress
Mabaruma	0.4	1.3	Government of Guyana	In progress
West Coast Berbice (utility scale)	4.0	N. A.	Peoples' Republic of China (PRC)	Feasibility
Port Kaituma	0.6	2.6	N.A.	N.A.
Kwakwani	1.0	1.8	N.A.	N.A.
Matthews Ridge	0.4	2.0	N.A.	N.A.

Source: compiled from multiple reports from GEA.

A4.5.3 WIND

There is some potential for wind power in coastal regions. Detailed wind assessments are yet to be undertaken to determine optimal locations for installing wind turbines. In 2007, an MoU was signed between the Government and DELTA Caribbean N.V. to construct a 13.5 MW Wind Farm at Hope Beach, East Coast Demerara. This project did not proceed as planned. However, Government is in talks with Total Energy Solutions Inc. who have formed the Hope Energy Inc. and are interested in developing a 26-megawatt wind farm at the same location. This would provide approximately 10 megawatts to the grid under a PPA with GPL.

A4.5.4 BIOENERGY

The use of bioenergy remains limited. Guysuco has been using bagasse to provide for the electricity and steam needs of its estates. The Demerara Distillers Limited (DDL) uses distillate waste to produce bio-methane for use in its boilers. GEA has assessed the potential of rice husk biomass for the generation of electricity. A list of locations, potential biomass quantities from rice mills and a map with the listing of all potential sources of rice husk energy sources have been completed. Although there is potential for scaling up given the available waste resources, technology constraints need to be addressed.

A4.5.5 ENERGY EFFICIENCY²⁴

Energy efficiency is required to prevent Guyana from becoming a net energy importer. It is also a critical component of the energy transition plan. According to results from IDB (2016), 77% of total electricity use in Guyana comes from the following five end-uses: motors, lighting, air conditioning, refrigeration, and mechanical ventilation. Therefore, energy efficiency measures should be targeted to these appliances and technologies.

In the same study, results suggest that energy efficiency combined with distributed generation is capable of reducing energy consumption at the expected levels of the Guyana Government. Under a medium-efficiency case, it could lead to 2,271 GWh in net savings when green economy interventions are phased in between 2016 and 2035, equivalent to about 14.5% in net electricity saved. Additional savings can be further realised, up to 23%, if distributed generation and displacement are adopted using solar PV in non-residential and public schemes for electricity and hot water systems.

Energy efficiency, however, is in a non-level playing field compared to supply-side energy markets and other traditional infrastructure investments with utility or service value.

The overall National Energy Policy of Guyana aims to provide universal access to green energy, enhance socio-economic activities, and improve the quality of life at the least economic and environmental cost. This translates to different fiscal and policy measures and targets to improve energy efficiency in six economic subsectors: residential, agriculture, transport, mining, industry and commerce, and tourism.

A4.6 Sustainable Transport System: Vehicle Fleet Management and Fuel Economy

A4.6.1 GUYANA TRANSPORT SYSTEM

The public transport system does not serve the mobility needs of the local population adequately. Starting with road network connectivity, some areas are less accessible with mobility challenges, particularly during inclement weather. This hinders not only the mobility of the local population, but access to goods and services and tourist traffic, particularly in the hinterland regions. Upgrading the profile of public transport is an immediate priority for the Government.

As 90% of population live in coastal areas, development of the transport network focused is on north-south road-based connectivity along the coast of Guyana, and is dominated by the road sector, which is further divided into the private and public modes. Interestingly, all road transport services are considered as private, including route-based transport services provided by buses and minibuses. It is common for buses and mini-buses to be owned and operated by private operators. However, these modes provide a public service and should be regulated by the government. Passenger service vehicles are further categorised into regular and specialised services, both of which have no fixed routes. Freight or cargo services are further

²⁴ For more analysis and energy demand forecast, see Annex B: Guyana Green Economy Modelling – A Study to Inform the Green State Development Strategy: Vision 2040.

categorised into special services. Cargo is further characterised as container loads, less-than-container loads, truckloads, and less-than truckloads. Each category has different impacts on weight and transportation impacts.²⁵

River transport is mainly provided by government-operated ferry services and small privately-owned riverboats. The ferry services along the Essequibo and Demerara Rivers are used to connect primary coastal area roads between Guyana and neighboring Suriname. And is managed by Guyana Transport and Harbour Department. Bridge infrastructure developments along the river systems have shifted demand from water to road transportation. As a result, the Government has reduced the Ferry's operation. Given Guyana's geography, river transport has potential in becoming an efficient and profitable mode of transportation, should the system be improved, it can serve as complementary routeways to the growing land transport sector.

Regardless of passenger or cargo service, road transport in Guyana has similar issues and concerns. Road connectivity is quite limited and road condition continues to deteriorate, largely because roads were not built to accommodate the current scale of motor vehicles and freight transportation. Further to this, traffic safety and of road accidents are on the rise and is a continuing priority being addressed by the Government.

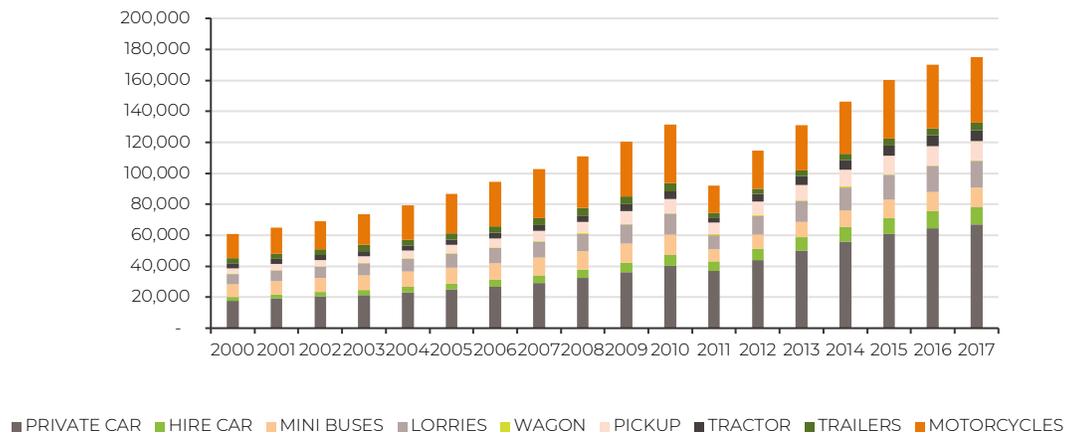
Railways were introduced in 1900 as a means to improve the transport network. They were discontinued in the 1970s due to high operating costs and poor passenger ridership.²⁶ The Government is holding discussions to re-introduce rail as passenger transport in response to the rapid motorisation of the country.

A4.6.2 MOTOR VEHICLE REGISTRATION

Between 2000 and 2017, annual vehicle registrations have nearly tripled at almost 0.18 million; light-duty vehicles constitute 70% of this number (Figure 6). In 2017, private cars accounted for 38% of the total registered vehicles. Heavy duty vehicles including lorry (freight) and trucks accounted for 17%. Results suggest that year-on-year growth of new registrations is declining.

²⁵ Lucas, R. 2016. Understanding the transport industry in Guyana Part 2. *Stabroek News*. 7 February 2016. Accessed at <https://www.stabroeknews.com/2016/features/02/07/understanding-transport-industry-guyana/>

²⁶ Ministry of Public Infrastructure. 2017. National Land Transport Strategy and Action Plan 2016-2026. June 2017. p13.

Figure 6: Motor Vehicle Registrations, 2000-2017

Adapted from Ministry of Finance Data, 2018.

Guyana's *Land Transport Sector Plan 2016-2026* noted that rapid motorisation and increased preference for private vehicles is a cause of concern, as the existing road network infrastructure may not be able to accommodate a steady increase in vehicle fleets. As early as 2012, restrictions on vehicle use, promotion of public transport, and other travel demand management strategies and policies were already being discussed as climate change mitigation measures in the energy sector. Travel demand management involves a general mix of policies, projects, or activities that reduce the need to travel. It also promotes use of public transport and other sustainable transportation modes. These policies are yet to be in place. There is an impression that implementing these measures are somewhat dependent on legislation identified in the draft *Sustainable Urban Transportation Strategy*. At the medium-term of Guyana's National Communication to UNFCCC, it is also an option to identify policies that are easier to implement.

Meanwhile, the growing preference for private cars and motorcycles is also reflected in the *2014 Public Bus Commuter Satisfaction survey*, which was conducted by the Central Transport Planning Unit. Results reveal 41% overall satisfaction rate among bus users in the country. Factors considered in the study include: bus availability during peak hours, ease of boarding and alighting, adequacy of space and comfort, and the manner of soliciting bus passengers. With public transport options limited to buses and vehicles for hire, more Guyanese are choosing to own private cars and motorcycles instead. This trend has implications on fuel consumption and emissions. As discussed, transport is responsible for the majority of end-use petroleum consumption. By petroleum type, the transport sector accounts for 98% of total gasoline imports, 27% of total diesel imports, and 57% of total kerosene and aviation fuel.

A4.6.3 VEHICLE OCCUPANCY AND ROAD USERS

Passenger occupancy data estimates the number of people inside specific vehicles and transport modes. This has an impact on the efficiency of the mode, and on mobility and energy consumption. Generally, private cars, motorcycles, taxis (hire car) and other private

modes (i.e. trailers/pickup) only carry one passenger per trip and therefore, severely underutilised. On the other hand, buses in Guyana have a seating capacity of 15 passengers for mini buses and 26 seating capacity for motorbuses. Unfortunately, there is no available vehicle occupancy and road user data in the transport sector, and this information should be collected in the future.

A4.6.4 ROAD NETWORK AND TRANSPORT BUDGET

There is room for improvement in road network and infrastructure connectivity. About 65% of the country's existing road network is unpaved. Cross-country access by land is also very limited: the Barima-Waini region, with a population of 26,941 (2012 Census), in the northwest of the country can only be accessed by river and air transportation. In terms of available financing for road infrastructure, data presented confirms that Barima-Waini, Cuyuni-Mazaruni, and Potaro-Siparuni receive the lowest actual budget allocation, amounting to less than half of that for East Berbice-Corentyne (the region with the highest accumulated infrastructure budget at GY\$1,238 million).

Across the board, transport infrastructure is improving; actual budget on roads and bridges increased by 130% from 2000-2005 and public transport by 179% in the same year. Waterway investment greatly increased over the last fifteen years, from 13% (2000-2005) to 98% (2010-2015). implying increased investment for improving and expanding the waterway transport.

Table 7: Roads and Public Transport Expenditure

Public Budget Spending	2000-2005	2005-2010	2010-2015
Roads, bridges	130%	-4%	17%
Waterways	13%	22%	98%
Public Transport	179%	-11%	10%

Source: Ministry of Finance. 2018

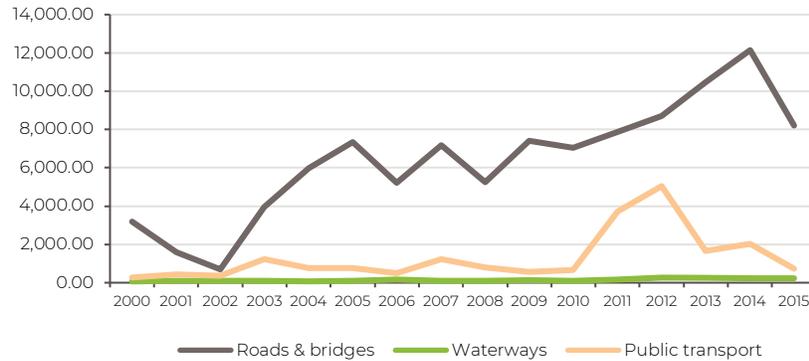
Actual budget in public transportation significantly increased from 2011-2014 but reducing greatly by 2015 (Figure 7). In consideration of Guyana's intention to shift demand to public transport, much investment on more efficient public transportation services will be required to realise improvements in the sector.

A4.6.5 ROAD ACCIDENTS

Based on reports from the Guyana Police Traffic Department Road Accident Database (2016), a total of 1,580 traffic accidents were recorded in 2016 resulting in 38 pedestrian fatalities. From 2010 to 2016 the *Road Accident Database* of the Guyana Police Force Traffic Department records show an average of 110 fatalities, 331 serious injury cases, 448 minor injuries, and 721 cases involving damage to property only. From a policy perspective, the *National Land Transport Strategy and Action Plan (2016-2026)* highlighted traffic safety as one of the major concerns that needs to be addressed. Three main factors are generally considered for road accidents: road (design, infrastructure and traffic engineering), users, and vehicle soundness. In terms of vehicles, brand new motor vehicles need to pass road safety tests before being sold in the market. Vehicles already in the market, however, are not always properly maintained

and are subject to the normal wear and tear. Even though registered vehicles are subject to an annual inspection, such inspections are not sufficiently rigorous and do not include best practices in vehicular road safety testing.

Figure 7: Public Transportation – Actual Public Budget (in GY\$ million)



Source: Ministry of Public Infrastructure. 2018.

A4.6.6 VEHICLE STANDARDS

Guyana imports rather than manufacture vehicle or assemble vehicles largely because there is no infrastructure available for auto assembly operations. All imported vehicles are either new, used or reconditioned. In 2016, Guyana imposed restrictions on the importation of motor vehicles, vans, buses, sports utility vehicles (SUVs) and pickups eight years and older from the date of manufacture to the date of importation. This restriction took effect in January 2018 and vehicles in these categories manufactured during or before 2009 will not be eligible for entry into the country. As a complement to these regulations, the development of vehicle standards and emission standards was identified by the expert group as an immediate priority in terms of safety, climate change mitigation and pollution control. The Environmental Protection Act 1996 empowers the Minister to make regulations regarding the quality of fuels, additives and lubricants that may be imported or used for vehicles.

A4.6.7 VEHICLE FLEET PROJECTIONS

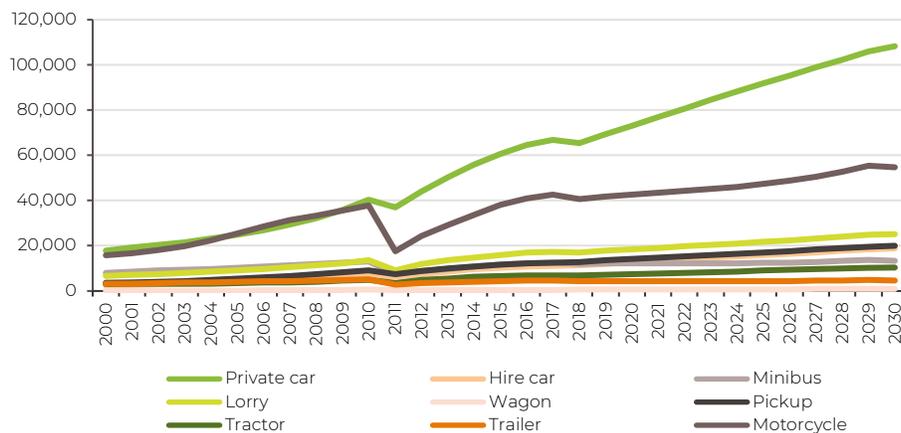
Figure 8 reveals that all vehicle types are expected to increase from 2018 to 2030, however a few types will increase more steeply than others. Private passenger cars and mini buses are expected to be dominant fixtures on roads in the longer term. This implies that a more aggressive vehicle fleet modernisation program should be considered.

It can be noted that considerable progress has been made since 2016 in a few important respects as regards vehicle fleet: (a) restriction of importation of used and/or reconditioned vehicles to less than eight years old from the original date of manufacture to the date of importation, with an exemption applied to vehicles used in manufacturing and agriculture sectors; (b) removal of excise taxes on vehicles under four years old and 1.5L horsepower; and (c) reduction of excise taxes from 50% to 10% on light- and medium-duty vehicles under four years old, between 1.5L and under 2.0L horsepower. This import restriction will help improve in

modernising incoming fleets, but there is no priority to phase out older, more polluting vehicles or for vehicles at end-of-life stages.

To encourage scrapping of old vehicles (10 years or older) replacing them with modern, fuel efficient and less polluting vehicles, a voluntary vehicle fleet modernisation program may be put in place. This type of programme can be implemented initially based on age of the vehicle, but Guyana does not yet have a mandatory policy and infrastructure for proper inspection and certification of vehicles that may be complemented by fiscal incentives and/or tax relief. Currently, in the absence of a phase out policy, such vehicles are sold unregulated in the second-hand market or left disposed on roadsides to corrode, adding to pollution. Metals from scrapped vehicles can be recycled, and therefore increase local availability of raw materials. Voluntary phasing out can be supported by tax incentives and deductions directed to vehicle purchase. Tax incentives for eco-upgrading and fuel retrofitting (e.g. dual-fuel or gas/LNG) could be introduced in the form of income tax deductions or import duties (e.g. technologies for upgrading such as catalytic converters) for profit-driven and privately-operated public transit systems (i.e. minibuses, lorries, taxis). This can be further complemented by a phase-in of electric vehicle fleets, which has been considered as priority technology in the 2016 Technology Needs Assessment Report.^{27,28}

Figure 8: Motor Vehicle Projections, 2000-2030



Note: Actual data = 2000-2017; Data from 2018 to 2030 are projected using time-series forecasting. Compiled from original data from: Ministry of Finance. 2018

A4.6.8 GHG EMISSIONS

Projections and Fuel Economy. Vehicle emissions are estimated for six pollutants: PM₁₀, PM_{2.5}, CO₂, NO_x, SO_x,²⁹ and hydrocarbons (Figures 9a-d). Results reveal that SO_x and hydrocarbons are generally tapering off across all vehicle types, compared to year 2000 levels. On the one hand, emissions from PM₁₀ and PM_{2.5} are expected to substantially increase through to 2030 for

²⁷ There are two registered privately-owned electric vehicles, Nissan leaf model.

²⁸ UN Environment. 2016. Identifying and Prioritising Mitigation Technologies as part of Guyana's Technology Needs Assessment (TNA) Project. April.

²⁹ PM₁₀ (Particle Matter 10), PM_{2.5} (Particle Matter 2.5), CO₂ (Carbon Dioxide), NO_x (Nitrogen Oxides), SO_x (Sulfur Oxide)

passenger cars, trucks and minibuses. CO₂ emissions are tapering off for medium- and heavy-duty vehicles; however these are still increasing for light duty cars. Currently, there is no fuel economy standards in place in Guyana. Petroleum imports however are generally in line with standard pollutant limits from existing fuel suppliers.

In Georgetown, GuyOil and Repsol stations are selling 95 octane gasoline and ultra-low sulfur diesel (ULSD). Shell is the only gas station that sells two types of gasoline: 92 octane (unleaded) and 95 octane. This implies that the quality of gasoline and diesel sold is already cleaner (15ppm). These are within the Euro 4 limit of 150ppm for diesel. This suggests that as more vehicles congest the roads, specific interventions will be required to curb pollutant emissions such as introducing non-petrol vehicles i.e. electric vehicles and biofuel blending mechanisms i.e. 3% ethanol or higher.

A4.6.9 AVOID-SHIFT-IMPROVE FRAMEWORK ASSESSMENT

Policies and initiatives for transport can be assessed using the avoid, shift, improve framework (ASIF) (Table 8). Most policies and initiatives focus on road passenger transportation and very limited information is available on freight. “Avoid” policies refer to measures that reduce the need to travel. “Shift” policies refer to influencing alternative and more efficient transport modes. “Improve” policies refer to measures that will increase efficiency in policy, implementation, and operations. Status “ongoing” means discussions/implementation has started but not yet completed. “Planned” refers to policies and initiatives found in official documents but has not started yet. “Not in place” means no information is currently available.

Table 8: Assessment of Road Transport Policies and Initiatives using the Avoid-Shift-Improve Framework

ASIF	Policy / Initiative	Status	Description
Avoid	Restrictions on private car use	Planned	Road charging, tolls, parking fees, increased vehicle license fees.
	Transit Oriented Development and land use planning	Not in place	Consideration of transportation planning in urban/rural areas and new developments to reduce need to travel
	Travel Demand Management	Not in place	Actions, policies, and programs that promote more efficient travel modes, reduce need to travel, or distribute travel demand
Shift - regulation	Parking management	Ongoing	Implementing parking management strategies in Georgetown, studies conducted with implementation on hold
	Fuel efficient vehicles	Planned	Mandatory vehicle fuel efficiency standards for all imports Regulations for vehicle imports that meet/exceed emission standards
Shift – information	Energy conservation in transportation	Ongoing	Information and education campaign of Guyana’s Energy Agency produced flyers on energy-

ASIF	Policy / Initiative	Status	Description
			saving tips including for transportation
Shift - incentives	Promotion of hybrid vehicles	Planned	Shifting to less-carbon emitting fuels and hybrid vehicles
	Incentives to promote alternative and less polluting fuels	Planned	Dependent on development of National Transportation Strategy
Shift - infrastructure	Rail public transportation	Planned	Envisioned in the National Development Strategy, 2010
	Cycling and walking paths Non-motorised transportation (NMT) alternative options	Planned	To be subsidised with revenue from road charges/tolls/parking fees/increased vehicle license fees
Improve - policy	National Transportation Strategy	Planned	This Strategy recommends developing standards for cleaner fuels and eliminate lead and sulfur emissions
Improve – efficiency	Vehicle Emission Standards for Guyana	Ongoing	Bureau of Standards developing emission standards since 2004. Stricter import regulations to ensure only compliant vehicles can enter the country
	Mandatory installation of pollution removal devices (e.g. catalytic converters)	Ongoing	Strengthen implementation of the Environmental (Air Quality) Protection Act 2000
Improve – operations	Bus fleet management and operations	Planned	Government fleet procurement policies.
	Bus fleet vehicle upgrading and	Not in place	Modernisation of bus and minibus fleet to improve road safety and comply with vehicle standards.
	Improve water-based transport as feeder to road transportation	Not in place	Developing ferry systems as an alternative mode of transport and feeder mode to main road connections
	Road Safety Audit (RSA)	Not in place	Assessment of road conditions and implementing safety measures to reduce incidence of road accidents
	Speed limit regulation and enforcement	Not in place	Mentioned in Guyana's Second National Communication to the UNFCCC
	Vehicle route length operation studies	Planned	Sustainable Urban Transport Study for Georgetown proposed bus routes and service operations
	Improved bus public transportation	Planned	Mentioned in Guyana's Second National Communication to the UNFCCC
	Transport data collection	Not in place	Improved coordination and responsibility sharing for data collection and management within

ASIF	Policy / Initiative	Status	Description
			the public transportation advisory committee.
Improve – fuel	Incentives for low carbon fuels CNG	Planned	Mentioned in Guyana’s Second National Communication to the UNFCCC
	Cleaner fuel options	Ongoing	95 octane gasoline available in GuyOil and Repsol. While both 92 and 95 octane gasoline available in Shell
	Fuel efficiency standards	Planned	Mentioned in Guyana’s Second National Communication to the UNFCCC
General	Road network connectivity	Planned	Mentioned in Guyana’s Second National Communication to the UNFCCC

There is room for improvement, which starts with road network connectivity. A few regions remain without roads, which hinders not only mobility of the population but access to goods and services in those regions. In terms of “avoid” policies, restrictions on private car use are reported in *Guyana’s Second National Communication to the UNFCCC (2012)*. However, private vehicle registration trends reveal otherwise. Rapid motorisation is considered to impact traffic congestion, road safety, and vehicle pollution. These concerns were among those highlighted in the *National Land Transport Strategy and Action Plan (2016-2026)* and the *Public Bus Commuter Survey Report (2014)*. In practice, it is difficult to implement road use restrictions even with legislation if there are no efficient alternatives to road transport.

Travel demand management are measures that influence road user behaviour to shift to more efficient modes of transportation or choose to travel at different time or areas to manage demand and alleviate traffic congestion. It consists of push and pull factors that are implemented simultaneously in order to give travelers more alternatives. Transit oriented development, road charging, parking management, and improved public transport services are among the examples of travel demand management. Moreover, a combination of these measures can be implemented per area or corridor basis, making the strategies customisable to different area needs.

Consistent with UNFCCC mitigation strategy, “shift” policies and initiatives promote environmentally friendly vehicles, cleaner fuels, and alternative transportation modes through development of rail mass transportation system, non-motorised transportation, and road user charges. Further to introducing fuel-efficient vehicles in the market, Guyana acknowledges the need for significant vehicle regulatory reforms in the short term. Baseline data is needed to realise these policies in the shift category. In terms of regulations, parking management studies are already available, however implementation is currently on hold. Emission standards are also being developed.

Compared to rail transportation investment, implementing bicycle, pedestrian and non-motorised transport facilities, is not as resource intensive. While it is expected that this

infrastructure is dependent on income from road user charges, these can be considered as local projects for implementation at the township levels.

In terms of Improving operations, consideration should also be given to implementing transport system management including street signs, signaling, and lane markings to improve road efficiency. In addition, Georgetown's *Sustainable Urban Transport Study* can be considered to pilot fleet modernisation as it recommends vehicle upgrading in the existing city bus fleet. The study serves as a basis for implementing improved public transportation services. It is also important to consider vehicle fleet management as not simply changing vehicles, but also to include management changes that need to be addressed i.e. minibus scheduling and dispatch times, performance standards, bus driver and conductor behavior. Overall, this suggests going beyond improving the vehicle to also including the level of service it provides to users.

A4.7 Government Policy, Institutions, Existing Strategy and Investment

The draft National Energy Policy (2017) is developed with broad guidelines on long term energy objectives and strategies. This is meant to ensure affordable, secure, efficient and sustainable supply of energy. It is the main policy that governs the energy sector in Guyana. There is so far no policy that specifically safeguards the sustainable exploitation of hydrocarbons. A Petroleum Law was formulated in 1998, however this requires revisiting and updating in light of the new oil and gas sector.

A4.7.1 INSTITUTIONAL SETUP

The legal and institutional framework for the energy sector in Guyana comprises a number of agencies within the public sector. The primary entity which holds the mandate for energy, hydropower, utilities and hinterland electrification is the Ministry of Public Infrastructure under whose purview lies the Guyana Energy Agency, Guyana Power and Light and Hinterland Electrification Company Inc. The Ministry of Natural Resources has played a central role in the oil and gas sector; a sector that will soon be under a recently named Department of Energy. The Environmental Protection Agency, Bureau of Standards, and the Public Utilities Commission are other agencies that have regulatory functions that include the energy sector.

The Guyana Energy Agency (GEA) is mandated to develop renewable and alternative sources of energy. Established by the Guyana Energy Agency Act 1997, the GEA conducts research and development into alternative and renewable sources of energy and dissemination and awareness of information relating to energy conservation and efficiency. The GEA also functions as a regulator in the downstream sector, namely licensing for importation, wholesale, retail, transportation, distribution and storage of petroleum products and fuel marking for imports of gasoline, diesel and kerosene.

The Guyana Power & Light Company Incorporated (GPL), a state owned vertically integrated utility regulated by the Public Utilities Commission, is the main national electric grid infrastructure service provider in Guyana. GPL is responsible for the generation, transmission and distribution of electricity to residential, commercial and industrial customers and it is authorised to purchase power from Independent Power Producers. GPL may therefore serve

as the primary off taker for energy generated by large scale renewable sources and, potentially, alternative natural gas.

The Hinterland Electrification Company Incorporated (HECI) is a company under the Ministry of Public Infrastructure. It was incorporated in 2015 as a subsidiary of National Industrial and Commercial Investments Limited (NICIL) as the holding company for all satellite electricity companies owned by NICIL, namely: Linden Electricity Company Incorporated, Kwakwani Utilities Incorporated, Lethem Power Company Incorporated, Port Kaituma Power & Light Incorporated, Mahdia Power & Light Incorporated and Matthew's Ridge Power & Light Incorporated. HECI is responsible for the extension and upgrade of electricity supply systems across the hinterland.

The Ministry of Natural Resources (MNR) has taken the lead on the oil and gas upstream sector, particularly on the issuance of prospecting and production licenses. Until recently, the Ministry of Natural Resources has continually been developing legislative policies, i.e. Local Content Policy, revision of the Petroleum Act, and National Upstream Policy - these are subject to public consultation and are at various stages of development. The newly created Department of Energy under the Ministry of the Presidency is expected to carry forward the functions specifically related to the oil and gas sector.

The Environmental Protection Agency (EPA) has the mandate to promote environmental management and protection. In this regard, it has various compliance and regulatory safeguards including requirements for completion of an environmental impact assessment for extraction of mineral resources.

The Guyana National Bureau of Standards (GNBS), under the Ministry of Business, has a growing interest within the energy sector. As a semi-autonomous body, its mandate incorporates the necessity for quality control and appropriate standards in the use of energy technologies and equipment, as well as labelling standards and codes which promote energy efficiency and competitiveness through the process of standardisation and verification of quality.

The Public Utilities Commission (PUC) is a corporate body established by the PUC Act with members appointed by the Minister for a three-year period. As a regulator, it covers a wide range of public services like electricity, telecommunications, water supply, transportation, etc. In relation to the electricity sector, the PUC shall be bound by, and shall give effect to, the GEA Act and the Electricity Sector Reform Act (ESRA). Currently, due to the lack of provisions for distributed generation in the ESRA, the PUC does not have a legal basis to regulate grid-connected systems below 10 MW and feed-in tariffs.

A4.7.2 ENERGY EFFICIENCY

There are immediate opportunities for reducing the energy demand of end-users. There is need for access to energy sources that are affordable, clean, and reliable. To achieve this together in the context of energy efficiency, a change in consumer behavior following the principles of the 'green agenda' is required. The draft National Energy Policy, which is still to be approved, has identified opportunities in moderating energy demand within the major economic sectors. On residential use, the policy objectives include, improving the reliability and security of the energy supply, and utilising solar and wind energy for household use.

In agriculture and transportation, opportunities are available in substituting agriculturally derived biomass and fuels for imported oil products. These include developing biodiesel from locally grown vegetable oil crops and producing sugar cane-based alcohol as industrial alcohol for transport fuel. This can also increase octane levels of gasoline by blending with alcohol sugar cane. Fossil fuels can be substituted with locally produced energy crops with co-benefits of water retention, soil conservation and can be used as building materials. Fostering a green transportation fuel industry, together with promoting agriculturally derived fuels, can support reducing local environmental and health impacts of the transport sector. For energy generation, agricultural by-products such as bagasse or dry sugar cane pulp can be used to add to the power generation supply in the national electric grid. Energy can also be produced from biomass resources such as rice husk and wood waste. While in terms of transport vehicles, developing the electric vehicle industry and integrating renewable energy in the transport sector are also opportunities to reduce energy demand. This can also be supported by incorporating fleet management practices for vehicles.

On the mining industry, Government policies focus on energy conservation and efficiency as well as enhancing the socio-economic development of surrounding communities. Industrial and commercial sector policies aim to increase the production of grid-tied and off-grid renewable energy as well as grid-tied cogeneration of electricity process heat. These sector policies aim to improve corporate management practices related to the energy management system.

The tourism sector aims to enhance the eco-tourism product of Guyana through using renewable energy, green building practices, recycling and waste reduction and reducing energy demand. Similar to the residential sector, the use of renewable energy sources at tourism facilities, and promoting eco-friendly tourism destinations, are also among the objectives.

A4.7.3 GREEN FISCAL POLICY AND SUPPORT MEASURES

Government policy features fiscal instruments for adopting demand reduction methods or efficiency-improving technologies by different end-users and responsible institutions. The fiscal incentives and pricing concerns are aimed at influencing consumer behaviour to reduce energy consumption or to choose more energy efficient options. Fiscal incentives will also be used to encourage the private sector in offering economic opportunities to local communities in terms of skills development, and infrastructure development by providing tax and custom exemptions. Other measures include providing tax relief to individual purchasers and project developers of sustainable energy technology. Import duties on sustainable energy equipment will also be waived.

GEA has been in the forefront of public awareness and promoting energy efficiency measures. In its *Strategic Plan* (2012-2016), GEA indicated its plans for energy efficiency Interventions in each of the following areas:

- Energy Assessment Audits – to understand the end use of electricity and determine energy efficiency measures
- Energy Efficient Buildings
 - Building Codes – to promote energy efficient building design
 - Occupancy Sensors – to reduce electrical energy usage

- Cool Roof – use of light-colored material to reflect heat
- Natural Lighting – more use of windows and skylights
- Energy Efficient Lighting – more use of CFLs and LEDs
- Refrigerant Replacement – natural refrigerants can save 15 to 30% in energy consumption
- Solar Water Heating – to be encouraged for residential and commercial use.
- Energy-Conscious Procurement Policy – to be developed and enforced.
- Labelling standards – development and enforcement of these standards.
- Prioritised Appliance Changeout Programmes – to be developed for refrigerators.
- ISO 50001 Energy Management Standard – to encourage its adoption.
- Transport Sector Efficiency – to explore opportunities for alternative transport fuel.
- Energy Efficient Street Lighting – test and evaluate and adopt the best type.
- Energy Efficient Cooking – to be used in hinterland communities.

A4.7.4 RENEWABLE ENERGY DEVELOPMENT

There are incentives available for renewable energy development. The Government implemented fiscal incentives for developers, such as tax and excise duty exemptions for renewable electricity equipment and corporation tax holidays for importers of items for wind and solar energy investments:

- One-off tax holiday of two years for corporation tax to importers of items for wind and solar energy investments;
- Lowering the excise tax on hybrid and electric vehicles;
- Granting tax exemptions to set up electric vehicle charging stations;
- Zero-rating the excise tax on biofuel.

Additionally, a number of items are zero-rated VAT and fully exempt from import duties: machinery and equipment for obtaining, generating, and utilising energy from renewable energy sources.³⁰ The availing of fiscal incentives, however, is a tedious process for business and investor applicants.³¹ In practice, businesses have difficulty with reimbursement processes to recover the taxes that are withheld under these programs.

A4.7.5 INFRASTRUCTURE INVESTMENTS

GPL is investing \$58 million to address losses at the distribution level of both medium voltage and low voltage networks. Over the span of the program a sustainable estimate of 2.3% reduction of technical loss is expected. Investment in transition lines, substations, and upgrading the distribution network amounting to \$48 million is expected to improve the quality of supply, increase demand, and affect loss reduction.

The *Consolidated Loss Reduction Strategy* guides the loss reduction measures by GPL. This includes programs established in the Inter-American Development Bank. European Union

³⁰ These include solar panels, solar lamps, deep-cycle batteries, solar generators, solar water heaters, solar cookers, DC solar refrigerators, DC solar freezers, DC solar air conditioners, wind turbines, water turbines and power inverters

³¹ Natalia Seepersaud, Deputy Chief Executive Officer, GoInvest.

funded the Public Utility Upgrade Programme (PUUP) and focuses on replacing current meters and upgrading these to an Advanced Metering Infrastructure (AMI).

This Strategy aims to replace 116,000 meters of installations with AMI compatible meters. 54,000 meters of which will be replaced as part of overall loss reduction in Component III of the PUUP. The phased implementation of AMI will be done using Power Line Communications (PLC) and a public education and social management program will also be set in place. Overall this investment aims to address the following:

- Transformer and conductor upgrading with the medium voltage and low voltage networks;
- Replacement and reinforcement of service lines;
- Improved load balancing;
- Transformer rightsizing;
- Additional transformer installations;
- Re-crimping jumpers and connections; and
- Re-crimping transformer drops.

The Arco Norte Interconnection Project involves the development of an electrical connection from Guyana to neighbouring countries Suriname and Brazil (Table 9). This project is expected to provide 7 GW of hydropower generation to Guyana and is suitable for both domestic demand and export to Brazil. While still in the feasibility stages, the first phase involving 161 km of internal paths in Guyana is expected for 2020 completion and 2026 operations. New transmission capacities will be focused in the country and new hydropower plants will also be located in the area. This implies that Guyana would become a major electricity exporter. Table 9 shows the indicative characteristics and completion dates for the Project.

Table 9: Arco Norte Connection Completion Dates and Main Characteristics of Transmission Lines

Route	Station 1	Station 2	Voltage (kV)	Line Configuration	Length (km)	Completion Date ¹
Guyana internal Path	SECC1	Garden of Eden	230	Double circuit	161	2020
Guyana-Suriname	Garden of Eden	Menkendam ²	230	Double circuit	431	2025
Roraima-Guyana	Boa Vista	SECC1 ³	500	Double circuit	395	2025

Note: ¹Completion date is indicative.

²The report refers to sub-station Menkendam, the exact location will be in Kwatta (approximately 15km west).

³ New intermediate substation located relatively near Tumatumari and Amaila sites (SECC1).

Source: Guyana Power Light Inc. 2017. Development and Expansion Programme 2017 – 2021.

In 2016, GEA completed the following low-hanging investments:

- Changeover of HPS street lighting to LED with annual savings of 42 MWh
- Changeover to LED lighting along with occupancy sensors in school building to save 35 MWh annually (GEA Annual Report 2016).