Sector: Energy	
Sub-Sector/Technology Option: Solar Power (On & Off Grid)	
Technology Application: Solar farms to service urban centers and supply the national grid.	
Introduction Direct solar energy has significant potential as an energy source, particularly, in electricity generation using photovoltaic (PV) systems. The generation of electricity using PV solar technology has advanced significantly worldwide with most of the installations as grid- connected. The International Energy Agency (IEA) ran a number of potential deployment scenarios and projected a contribution from solar PV of 10% by 2050 to the global electricity supply (Arvizu*et al*, 2011). Guyana's main source of energy is imported petroleum-based products. Renewable energy sources contribute marginally to the energy mix in the country with solar photovoltaics accounting for approximately 1%[35]. The electricity generating sector was the second largest consumer of imported petroleum-based products (31% in 2013) (GEA, 2014). The industrial and residential sub-categories, accounted for 33% and 37% consumption in 2013 respectively, of electricity generated via the use of fossil fuels (GEA, 2015). Therefore, significant potential exists to develop and install solar farms using PV power systems for integration into the national grid.	
Technology Characteristics	
Features	Photovoltaic (PV) solar technologies allow for the direct conversion of light to electricity. PV power systems are classified into two (2) types – those connected to the traditional power grid (grid-connected applications) and those not connected to the grid (off-grid applications). Off-grid PV systems can service areas without electricity access and can be established as centralized PV mini systems in villages or towns/urban centers. Grid-connected PV systems use an inverter to convert electricity from direct current (DC) to alternating current (AC) and the generated electricity is then supplied through the distribution network to consumers. This kind of system does not require energy storage since the grid is used as a buffer. Grid connected PV systems are further classified into two (2) types of applications – distributed and centralized. Grid-connected distributed PV systems can be installed to generate electricity directly to the electricity network or grid-connected customer can be on public buildings and integrated into the demand side of the electricity meter. This kind of system range in capacity of 1-4kW for residential systems and 10kW up to several MW for rooftops on buildings.

[35] GEA November 27, 2015

	Grid-connected centralized PV systems function similar to a centralized power station and are mounted on the ground in capacity larger 1MW.
Capital Investment Cost	Even though PV prices have decreased more than a factor of 10 over the last 30 years, the cost of electricity from this technology was found to be still relatively high. Local conditions and cost of individual system components contribute significantly to the localized cost of electricity (Arvizu*et al*, 2011). The cost of the PV module takes up the largest component of the investment cost followed by the costs of the balance of system (BOS) components (Arvizu*et al*, 2011). Globally, the average PV module price dropped from 22USD/W in 1980 to less than 4USD/W in 2009. Prices for larger systems such as PV electricity generation with grid connected applications were found to be about 2USD/W in 2009[36]. According to IRENA (2015), the average levelised cost of electricity (LCOE) of residential PV systems without battery storage was estimated to be between USD 0.14kWh and USD 0.47kWh in 2014.
Operating Cost	The operating and maintenance costs of PV electricity generation systems were found to be low and in the range of 0.5 and 1.5% annually of the capital investment costs[37].
Maturity	Wide range of solar technologies of varying maturities is available. Specifically, the use of PV electricity generation systems with grid connectivity is widely established internationally. Further PV technological advances are possible that could lead to further cost reductions.
Country Specific Applicability	
Status of technology in country	Approximately 1.2MW solar PV systems were installed across Guyana generating an estimated 1.81GWh annually. Off-grid PV systems were installed mainly under the Unserved Areas Electrification Programme (UAEP) where a total of 19,000 systems were installed in homes, schools and community buildings across hinterland villages (GEA, 2014). The GEA installed an 8.46kW grid-connected distributed PV system demonstration project on site to promote the

[36] IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2011) & www.climatetechwiki.org

[37] IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2011)

	use of solar PVs and generates about 10.9MWh of energy annually (GEA, 2014). The subsequent installations of similar systems at the National Parks Commission, at GEA and a private firm translate into a capacity of 66 kW for grid-connected solar PV systems. The GEA is also planning to install about 180kW of solar PVs for grid-connection on rooftops of schools and other buildings in selected areas by the end of 2016 (GEA, 2015[38]).
Market potential	Applicability of solar technologies depends on local conditions and supporting policies for adoption. Solar water heaters and DC home solar light kits are being used locally, though limited. There is significant potential to expand the sources of energy for electricity generation to include PV electricity generation systems.
Scale of application and time horizon	Medium to long term. Fully operational by 2020.
Institutional and Organisational requirements	Directly, the institutional and organizational requirements for solar PV systems are embodied in the mandates of the GEA and Ministry of Public Infrastructure. The GEA will actively pursue and support the installation of solar PV systems around the country given that supporting policies are in place. Additionally, as it relates to securing land and permits for operation, the Guyana Lands and Surveys Commission and the Environmental Protection Agency will have oversight responsibility.
Operation and maintenance	Would require extensive institutional capacity and specialized skills to install and maintain PV systems.
Scale/size of beneficiary group	Beneficiary groups could be varied depending on the scale of applicability and acceptance of the technology.
Acceptability to local stakeholders	Additional sources of energy for electricity generation are encouraged and PV systems are easily acceptable by all stakeholders.
Endorsement by experts	PV electricity generation systems are encouraged by local and international experts and recognized as an additional source of energy for the electricity generation sub-sector in Guyana.
Barriers and Disadvantages	▪ The main issues related to PV electricity generation systems are siting and the land requirements for PV plants and solar farms. ▪ Permitting and financial challenges can persist to impact the development of land for utility-scale projects. ▪ Lack of access to transmission lines for large projects far from electric load centers.

[38] Point made at the working group meeting November 27, 2015.

	▪ PV systems mounted on the ground have unintended visual impacts. ▪ Generation of electricity by PV systems could vary systematically – during the day, year and based on weather conditions. ▪ The production and decommissioning of solar cells could have environmental impacts. ▪ The legal framework to allow for interconnection to the national grid through power purchase agreement since the local utility (Guyana Power and Light) holds a monopoly on the generation and supply of electricity.
Mitigation Benefits	
Greenhouse gases abatement potential	Solar PV systems have significant direct GHG mitigation potential by displacing fossil fuel-based electricity generation plants and reducing the amount of carbon emissions produced through fuel consumption in the sector.
Potential Development Benefits: Economic, Social, Environmental	
Economic benefits	▪ Direct job creation through installation and maintenance of PV systems. ▪ Energy security through diversified energy sources for electricity production. ▪ Cost savings due to reduced imports of total petroleum products. ▪ Grid-connected distributed PV systems allow for reduced losses in the electricity network since the system is installed at the point of use and costs are reduced if mounted on existing structures. ▪ Large grid-connected centralized PV systems allows for optimization of installation and operating cost through bulk sourcing and cost effectiveness of the PV components and balance of systems at large scale.
Social benefits	▪ Generate income due to investment and employment through the establishment and operation of solar farms. ▪ Capacity development of locals through training and capacity building in the use and maintenance of solar technologies. ▪ Potential improvement in health and livelihood of populations not served by the national grid.
Environmental benefits	▪ Grid connected-distributed PV systems that are roof- mounted do not require additional land for the PV system

	▪ Solar PV systems are considered closed systems – during operation and electricity production no inputs such as fuel are required. ▪ Can be considered environmentally benign - no noise or vibration from the operations.

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