## Annex 1: Technology Factsheets

### Technology: Wind Turbines (On Shore)

### Definition and description

Wind Turbines use the power of the wind to drive a generator in order to produce electricity. The output depends on the wind speed. Hence, when there is no or not sufficient wind there is no electricity. At the same time when there is too much wind the turbines are turned off for safety reasons.

Wind turbines are available in various sizes and types. From small scale types often seen on yachts to 250 m high power plants everything is possible. Furthermore, wind turbines can be installed on shore, off shore or even flying. This fact sheet will discuss onshore applications even though the coastal areas east off Grenada could in theory be used for off shore applications too. Furthermore this fact sheet concentrates on utility scale systems.

Due to the potential occurrence of hurricanes, wind turbines deployed in Grenada either have to be able to withstand wind speeds of more than 250 km/h or should have a mechanism to retract the whole system. Though it is technically possible to build a wind turbine that would survive a category five hurricane it most likely will not be economic. Consequently it might be more reasonable to use medium scale retractable systems in this region.

### Potential in Grenada[1]

Grenada has a long history of using wind power as may be seen in the ruins of several wind mills along the east coast. There is a steady breeze from the eastern direction. Wind databases like IRENA's Global Atlas for Renewable Energies and the World Bank's globalwindatlas.info indicate average wind speeds of at least 7 m/s along the eastern corridor as well as Carriacou and Petite Martinique. These values have been confirmed by measurements performed by GRENLEC. GRENLEC investigated several promising potential locations including one on Carriacou. Based on the results, full load hours of more than 3,000 h seem realistic for the best locations. This compares to very good locations in the UK and even off-shore systems in the North Sea.

However, due to the relatively dense populated coastal corridor on the east coast it will be difficult to find locations where there is enough clearance between the turbine(s) and dwellings to avoid a nuisance in terms of noise, light flicker, etc. In order to increase the number of possible locations mountain tops have been considered, however, in addition to environmental issues this would most likely not be economic. Consequently, there is a limited number of possible locations leading to an overall potential of approx. 10 MW. In order to achieve higher capacities larger none retractable turbines would have to be deployed at the risk of taking harm during hurricanes.

[1] Due to the lack of detailed analyses the potential has been estimated based on available data and assumptions.

10 MW with 3,000 assumed full load hours would provide 30 GWh per year or 14 % of the current overall production.

**Mitigation to climate**

The above mentioned potential of PV electricity could reduce Grenada's greenhouse gas emissions by 19 $kT^2$ of $CO_2$ equivalent through the replacement of diesel fuel for electricity generation.

**Advantage(s)**

- Proven, mature and reliable technology
- High capacity factor in the region
- Job opportunities for technically skilled (tertiary education) people in the field of operation and maintenance

**Disadvantage(s)**

- Environmental (potential bird strike) and health concerns due to noise and shadow/flicker
- Variable source of energy increasing the demand for storage and/or backup capacities
- Limited human capacity and expertise in Grenada increasing the risk of malfunctioning systems
- Due to small market size and high cost of capital, system and energy generation costs are still considerably above international average despite good wind situation
- High upfront costs

**Costs and other financial requirements**

So far there are only a small number of micro to small scale pilot systems in Grenada. Consequently no data on actual costs is available. In 2014 the Government issued a tender for a MW wind park in Carriacou. However, the bids received exceeded the budget making the project not economic. This shows that due to the virginity and small size of the market system costs are high compared to international averages.

On an international level electricity generation cost (levelized cost of electricity, LCOE) varies between 0.04 US$/kWh and 0.15 US$/kWh depending on system size and wind potential for mid to large scale systems with IRENAs global weighted average in 2017 being 0.06 US$/kWh. Consequently, provided system costs and cost of capital can be brought to a reasonable level, wind power should be cost competitive to current diesel generation. Furthermore wind power, like solar photovoltaics, geothermal and other non-fuel based renewables will have a constant price over the life time making electricity production independent of volatile global fuel markets.

**Status of the technology in Grenada**

[2] Based on UNFCCC "Standardised baseline: Grid emission factor for Grenada" and an electricity generation distribution of 95.7 % in Grenada, 3.9 % in Carriacou and 0.4 % in Petite Martinique.

A few micro to small scale pilot projects have been installed in Grenada. However, none of the systems is operational today.

A 2 MW development has not become reality due to uneconomic bids.