Technology Fact Sheet for Mitigation

E. Wind Turbine [i]

1. Introduction	
1.1. Historical	- Wind power technology is proven option for generating electricity and become very popular where resources area available and sufficient enough [Velocity>5 m/s] like coastal regions - By the year 2003, capacity commercial wind turbines ranges between 600 kW to 2.5 MW against only 25 kW twenty years ago (The Power Guide, 1994, and ESMAP, 2000)
1.2. Location of Resources	- Ares more flat, such as the Lake Kivu water surface or the tops on mountains characterized with a morphology favourable to the wind flow - Average for stations with datasets records is about 2 m/s above ground - Vertical gradient is increased at about 100 m above ground - Periods for which velocity is higher than 5 m/s are mainly the afternoons
1.3. Variability of Resources	- Wind resources are very limited in Rwanda(being spatial distribution, velocity of air, frequency, duration)
2. Brief Description	
2.1. Conditions	- Wind atlas is required before any exploitation; frequency and variability of wind velocity - Identification of potential sites and preliminary design and pre-feasibility

	studies
2.2. Characteristics	- Wind is captured by the blades of the of the rotor of the turbine - Rotor to alternator, through a transmission shaft - Induction alternator (more flexible, direct connection to the grid, power electronics control) or synchronous alternator (gearboxes, revolution of rotor is increased with wind speed - Typical commercial turbine = 600 kW to 2 500 kW - Wind tower: 65 m to 100 m; lattice (bolted structure) or tubular (more withstanding vibrations, easy access to the nacelle); the yaw control (for orienting the rotor in wind direction) - Option of batteries, mini-grid for villages via a DC – AC inverter
3. Applicability and Potentialities in Rwanda	
3.1. Applicability	- Refer to the about paragraph n° 1.2 and 2.1
3.2. Potentialities	- At the top of mountains - Along the Lake Kivu - Locations: Historically known for rich resource of wind flow
3.3. Limitations	- Wind speed variation - Frequency and duration of acceptable value of wind speed - Mountainous topography and morphology limiting the wind - Location of a country vis-à-vis large oceans

4. Status of the Technology in Rwanda	
4.1. Local Production	- NA
4.2. Shared Power Plants	- NA
4.3. Projects	- Wind atlas project is being implemented; preliminary measurements proved that wind velocity at 40m above ground surface is in the range of 2.3 m/s to 4m/s
5. Benefits to Development	
5.1. Social	Opportunity of setting up hybrid wind/ solar at small scale in selected rural areas
5.2. Economic	Remote areas can develop non-agricultural incomes based on among others water pumping systems, in fact, wind resources in Rwanda are more eligible to running pumps instead of generating electric power
5.3. Environmental	- No GHG emissions - But, impact of noise, bird death, land acquisition, aesthetic and visual consideration location – specific impacts and mitigation
6. Climate Change Mitigation Benefits	
6.1. Reduction GHG Emissions	Wind is a clean and renewable energy
6.2. Low Carbon Credits	Wind is highly eligible to carbon credits
7. Financing Requirements and Costs	
7.1. Private Sector Involvement	Small scale wind solar hybrid systems and water pumping by wind are relatively affordable and thus a private sector involvement has to be initiated and promoted
7.2. Capital Cost	- Up to 2 300 USD/kW for a typical 100 kW - About 1 100 USD/kW for a 10 MW capacity

7.3. Generating Costs	- 31% of the total generation cost for a 100 kW - 12% of the total generation cost for a 10 MW - Generation cost is 19 and 6 US cents/kWh respectively for a 100 kW and a 10 MW - Thus, the higher the power capacity, the lower the cost
7.4. GHG Emissions	Wind is a non-carbon emissions Its emission factor is very low: 43kg/MWh
7.5. Capability Building	Training for design of wind options is highly recommended especially due to the intermittent behaviour of wind distribution in Rwanda

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment and Technology Action Plans For Climate Change Mitigation– Rwanda. You can access the complete report from the TNA project website http://tech-action.org/**