Technology Fact Sheet for Mitigation

A. Large Grid Connected Solar Photovoltaic Technology [i]

1. Introduction	
1.1. Historical	- The first steps of PV technology proved that special material of semiconductors convert directly the sunlight into electricity. - Process of preparing such materials require about 1 400 °C, this is why, and among others, that PV systems are expensive - Worldwide production was only 5 MW in year 1982 and substantially increased to 385 MW in year 2001 - Above trends are regarding mainly small-scale solar PV - In fact, large grid-connected solar PV technology is relatively new, but highly promising
1.2. Location of Resources	- Whole country
1.3. Variability of Resources	- Stable , equatorial zone
2. Brief Description	
2.1. Conditions	- Solar radiation: globally about 5 kWh every day and per one square meter of a receiver surface - Conditions for a proper production of electric power directly connected to national grid, or any mini-grid, are complex due to required agreements between EWSA and private sector expected to invest in large-scale PV such as 5 MW or more
2.2. Characteristics	- Below description of characteristics of

	a 5 MW solar PV plant is based on a modular unit of 73 kW [http://www.caddet.org] ✓ PV area: 532 m^2 ✓ PV efficiency: 14% ✓ Inverter efficiency: 85% (DC to AC) ✓ Total incident radiation: 526 MWh/year ✓ Total incident: 55 MWh/year - Such a modular unit can result in a larger PV plant once about 70 units are assembled and provide 5 MW - Connection to the national grid is more appropriate for reducing the cost by avoidance of use of batteries; thus the capacity factor equals the daily sunshine duration (in Rwanda about 6 hours) - Lifespan of main components: 25 years - Best materials: Crystalline silicon - Remark: Optional scenario for reduction of cost = concentrating solar in order to use less size of solar modules (Requirements of about 5 kWh/m^2 for the beam direct normal solar component)
3. Applicability and Potentialities in Rwanda	
3.1. Applicability	- Based on lessons and experience for grid-connected solar PV in USA, in Europe and in North Africa, applications of large-scale PV is feasible in Rwanda

3.2. Potentialities	- Over the whole year, the incident solar radiation is, as average, about 5 kWh/m^2 - Particularly during the two rainy seasons, the solar radiation remains sufficient due to the fact that the solar declination is almost matching the latitudes in Rwanda (Duffie et al, 1988)
3.3. Limitations	- The main constraint to the deployment of solar PV systems in Rwanda is due to initial cost of investment which is very high in addition to the fact that the payment of acquisition is cash instead of loans from Banks
4. Status of the Technology in Rwanda	
4.1. Local Production	- Access to commercial solar PV modules is made easy due to the maturity of such technology in Europe, USA, China and Japan - Assembly of solar calls resulting in such modules locally in Rwanda is possible but not yet done; but in year 1993, a small workshop in actual Muhanga District was assembling cells resulting themselves in small modules
4.2. Shared Power Plants	- NA
4.3. Projects	- EWSA presented recently in February 2012 at Kigali an opportunity of investing in large-scale solar PV and an alternative of grid-connected expected for short term
5. Benefits to Development	

5.1. Social	- Especially, rural population will be more committed to join the Umudugudu policy and settlements - Facilities like charging phones, iinternet and TV access are thus becoming more popular
5.2. Economic	- Promotion of exploitation of local natural resources for electric power generation - Reduction of exodus from rural to urban areas - Small scale business and factories are more promoted and increased towards a better GDP and incomes - Increases rate of access to electricity services and thus to good growth of economy - Creation of jobs
5.3. Environmental	- Decrease of use of wood and charcoal fuels, of petroleum for lighting - Increase of promotion of electric vehicles through wider available battery stations
6. Climate Change Mitigation Benefits	
6.1. Reduction of GHG Emissions	- Solar PV is a non carbon technology - Batteries are not required in case of grid-connected solar option - In case of replacing the existing thermal oil power plants by large solar PV , the rate of contributing to the reduction of GHG emissions is about 79%. - In fact the emission factor of solar PV

	grid is about 155 kg / MWh against 750 kg/MWh and 1075 kg/MWh respectively by the oil and peat use.
6.2. Low Carbon Credits	- Grid-Connected Solar PV, being a non-carbon resource, will hence contribute in carbon market
6.3. Specific Sectors of Health	- Air and water quality are conserved due to use of such a clean source of electricity - Pollution is limited or avoided
7. Financing Requirements and Costs	
7.1. Private Sector Involvement	- Even Solar PV systems, there are popular in Rwanda; therefore private investors can be attracted by the approach of grid-connected solar power. Such a scenario is today planned by EWASA and MININFRA in Bugesera District
7.2. Capital Cost	- For instance a 5 MW of PV had its initial capital cost of 7 060 USD/kW - Projection for the year 2015: about 4500 to 5 500 USD/Kw
7.3. Generating Costs	- Projections for the year 2015: total energy generation cost is in the range of 25 to 33 US cents/kWh - Total levelized cost in year 2005: 42 US cents/kWh - The O & M costs are negligible
7.4. GHG Emissions	Slight emissions are associated to the process of preparation and transformation at high temperature before reaching the finished solar cells
7.5. Capability Building	- Small solar PV systems are often

	installed in Rwanda and technicians became sufficiently skilled - But, it is not the large and grid-connected solar power technology; such a new scenario in Rwanda requires more skilled staff technicians

[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/**