Technology Fact Sheet for Mitigation

D. Concentrated Solar Power (CSP) with Storage System [i]

1. Introduction	
1.1. Historical	- CSP is a high temperature solar power technology - First solar concentrator and steam engine, in Egypt in year 1913 - USA, in 1991, an area of mirrors and receivers generate 384 MW of electric power and are today still working properly - Spain, followed the example of USA and constructed - Options: parabolic through is more reliable
1.2. Location of Resources	- Solar radiation in Rwanda is available the whole year and even during rainy seasons - CSP utilizes only the sunlight tracking component (direct normal solar) and Eastern Province is more favourable while high lands in North or West are favourable only in absence of cloudy periods - Inter seasonal variability is low
1.3. Variability of Resources	- Direct normal solar irradiation component(DNI)of the global solar radiation (direct plus diffuse)is proportional to duration of sun shine: average of six hours per day in Rwandan sunny regions
2. Brief Description	

2.1. Conditions	- Need of information of spatial and daily distribution of solar energy, especially its beam component which can be tracked (DNI = 0, i.e. Direct Normal Solar Radiation) - Need of enough land for installation of field area of collectors/mirrors - Need of agreement between the owner of the power plant and EWASA for an alternative of direct connection to the national grid instead of installation the system for thermal output storage
2.2. Characteristics	- Direct perpendicular component of solar radiation on a mirror (parabolic, spherical) is tracked by a mechanical tracking system from 06h00 to 17h00 - Then such a flux of solar energy is focused and concentrated on a small absorber (black painted) - Via a system of pipes containing a thermal working fluid, such a fluid is heated by the absorber - Step of transfer of heat to water becoming a steam with high temperature and high pressure - Finally, a steam turbine and an alternator are rotated by such a steam - Option of a thermal storage molten salt system (higher cost) - Option of direct connection to an available grid network without any thermal storage
3. Applicability and Potentialities in Rwanda	

3.1. Applicability	- A proper design and pre-feasibility studies are required before any conclusion regarding the level of applicability in Rwanda - Only indicative preliminary studies on DNI variability are available but not yet validated (Museruka, 2011)
3.2. Potentialities	- Preliminary studies prove that area Rwanda are characterized a stable DNI resources: about five kWh/m^2 per day; in fact the elevation constant angle is about 0.5; there is also an opportunity of permanently tracking the DNI incident on ground surface
3.3. Limitations	- For some months, the DNI component equals and even exceeds the global solar radiation
4. Status of the Technology in Rwanda	
4.1. Local Production	- NA
4.2. Shared Power Plants	- NA
4.3. Projects	- NA
5. Benefits to Development	
5.1. Social	Refer to above other technology options
5.2. Economic	Idem /ditto
5.3. Environmental	Idem /ditto
6. Climate Change Mitigation Benefits	
6.1. Reduction GHG Emissions	Refer to above other clean technology options
6.2. Low Carbon Credits	Such a new technology is highly eligible to carbon credits; it is a short term option, in fact it already commercial in leading

	countries(USA, Spain)
7. Financing Requirements and Costs	
7.1. Private Sector Involvement	Special incentives, subsidies and particular studies for design are both required for motivating the involvement of private sector in such a technology
7.2. Capital Cost	- Capital cost for a typical 30 MW: - In year 2005, about 2 480 USD/kW and 4 850 USD/kW respectively for option without storage and option having a molten salt storage tanks system - Projection to year 2015: about 2 000 USD/kW and 4 000 USD/kW - Compared to a solar photovoltaic, the capital cost of the latter is 3 to 2.5 times more higher This CSP technology of concentrating and tracking incident direct normal solar radiation is becoming very attractive and promising
7.3. Generating Costs	- CSP without storage (i.e. directly connected to national grid): 18% of total generation cost which was 13 US cents/kWh in year 2005 and projected to 11 US cents/kWh in year 2015 CSP with a thermal storage: 22% of total generating cost (18 US cents/kWh in year 2005)
7.4. GHG Emissions	CSP technology is mainly based on solar fuel and optical parabolic mirrors; thus it is a very low carbon emission The emission factor(about 43 kg/MWh) is lower than the case of solar PV

7.5. Capability Building	Local expertise is to be trained for handling such a promising new technology requiring, in its design, additional components(heat storage, backup system, optional connection to national electric grid)

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[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/**