Technology Fact Sheet for Mitigation

Technology 1: **Concentrated solar power** [i]

Subsector	Energy supply
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Concentrated solar power (CSP)**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Concentrated solar power (CSP) systems concentrate the energy from the sun for electricity production. This is done by heating a fluid which is then used to raise steam for a conventional turbine for on- and off-grid electricity provision. These systems can also provide heat, either at high temperatures directly for chemical reactions, e.g., chemical processing, or as a by-product for desalination plants or cooling systems, depending on requirements. They can be installed in deserts or any high insulation area. The size of the area needed for the mirrors varies according to the output required and the type of system. Solar thermal can integrate well with conventional power generation equipment and advanced technology. Conventional materials are used with modular construction. There are three basic designs for CSP, but all use mirrors to concentrate the energy from the sun onto a receptor vessel which may contain a liquid or gas which is heated and then used to power a steam turbine (Dell and Rand, 2004) A simple parabolic dish focuses the sun's energy onto a thermal receiver mounted at the focal point of the dish. Temperatures greater than 1000°C can be reached. Due to its limited size the output from one dish is about 25 kW at maximum. Another type is the 'central receiver' type or solar tower which has thousands of mirrors able to track the sun and these are arranged round a central tall tower. A heat transfer fluid (such as a molten salt, air, water/steam, liquid sodium) flows through the receiver collecting the heat. The temperatures involved are in the range of 300-1000°C. This is then used to make steam to generate electricity with power outputs in the range of 30-200 MW. If air is used at 1000°C then it can be used directly in a gas turbine (60% efficiency) replacing natural gas. The third type of arrangement is the parabolic trough principle. The parabolic trough mirror tracks the sun and may be up to 100 m long. At the focus of the mirror, there is a heat pipe which carries away the heat produced. The temperature range is lower at 200-400°C and arranging the troughs in rows allows a flexible power output ranging from 30 to 350 MW. http://climatetechwiki.org/technology/csp CSP is commercialized and the CSP market has seen about 740 MW of generating capacity added between 2007 and the end of

	2010. More than half of this (about 478 MW) was installed during 2010, bringing the global total to 1095 MW. Spain added 400 MW in 2010, taking the global lead with a total of 632 MW, while the US ended the year with 509 MW after adding 78 MW, including two fossil–CSP hybrid plants. http://en.wikipedia.org/wiki/Concentrated_solar_power#Costs
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The total solar energy resource, evaluated on the annual solar radiation on the entire national territory, has been calculated to have the potential to achieve 2.2 x 1012 kWh. The potential solar energy varies from 1,200kWh/m^2/year to 1,600 kWh/m^2/ year in the different regions of Mongolia. According to the "Master Plan Study for Rural Power Supply by Renewable Energy in Mongolia", up to 20 percent of the country's electrical power energy will be supplied from renewable energy sources by the end of 2020. The huge potential for solar energy in Mongolia makes it possible to implement CSP technology. But it is important to get international support in order to build the solar thermal power plants and to get international grants or soft loans to finance the project. 40 MW CSP capacities have been considered to replace 20 MW conventional coal based power plant in general. The capacity utilizations of CSP and conventional coal power plant are 35% and 70% respectively. The replacement capacity is based on an equivalent energy output by both power plants. The CSP plant will not produce direct GHG emissions
Reduction in GHG emissions	The GHG emissions from a 20 MW coal fired power plant is calculated as follows: The coal fired power plant will generate electricity about 110000 MWh (20MWx5500h) If electricity consumption is converted to CO_2 emissions it will be 121,000 tCO_2 (110,000 MWh x1.103tCO_2/MWh)[1]. The one CSP plant of 40 MW can reduce GHG emissions by 121,000 tCO_2-eq/year. Then 4 CSPs could reduce GHG emissions by 484,00 tCO_2-eq/year
Impact Statements - How this option impacts the country's development priorities	
Social development priorities	

[1] Calculated as weighted average of the country specific OM and BM emission factor values provided by Mongolian DNA (1.1501 respectively 1.0559); see website:http://www.cdm-mongolia.com/index.php?option=com_content&view=article&id=75&Itemid=105&lang=en

Economic development priorities	Mainly through funding from GEF and other international organizations, private companies and national governments, the following countries have become involved in developing solar thermal power plants based on parabolic trough design: Algeria, Egypt, India, Iran, Mexico, and Morocco. Other countries interested or actively pursuing CSP are Jordan and South Africa. Brakmann et al. (2005) point out that Global Market Initiative recommends that developing countries that are not interconnected to industrialized countries in Europe should have preferential financing with grants or soft loans, etc. http://climatetechwiki.org/technology/csp Although there is a high initial cost for CSP, the construction of CSP could save coal and give economic benefits.
Environmental development priorities	The CSP plant can reduce air pollution by increasing coal consumption in power plants.
Other considerations and priorities such as market potential	Market potential is big
Costs	
Capital costs	As of 9 September 2009, the cost of building a CSP station was typically about USD2.50 to USD4.0 per watt depending on the local solar resource conditions, while the fuel (the sun's radiation) is free. Thus a 250 MW CSP station would have cost UDS600–1000 million to build. That works out to USD0.12 to USD0.18/kWh. To put this in perspective, Arizona Public Service (APS), Arizona's largest utility company, purchases power from the Palo Verde Nuclear Generating Station at a cost of USD0.0165/kWh. Nonetheless, new CSP stations may be economically competitive with fossil fuels. Nathaniel Bullard, a solar analyst at Bloomberg New Energy Finance, has calculated that the cost of electricity at the Ivanpah Solar Power Facility, a project under construction in Southern California, will be lower than that from photovoltaic power and about the same as that from natural gas. However, in November 2011, Google announced that they would not invest further in CSP projects due to the rapid price decline of photovoltaics. Google spent USD168 million on Bright Source. http://en.wikipedia.org/wiki/Concentrated_solar_power#Costs 40 MW CSP capacities have been considered to replace 20 MW conventional coal based power plant. The capacity utilizations of CSP and conventional coal power plant are 35% and 70% respectively. The replacement capacity is based on equivalent energy output by both power plants. It is assumed that the capital cost of CSP is 3.1million USD/MW including equipment and construction, planning. The capital cost of conventional coal based power plant is 1 million USD/MW including equipment, construction and planning.

Operational and Maintenance costs	FICAM model is used in order to calculate all costs and emissions. The total annual cost of the CSP plant is USD12 million, compared to the annual cost of USD6 million for the conventional coal based power plant.
Cost of GHG reduction	The reduction of GHG emissions in CO_2-eq is 120384 tons with in annual cost of USD5 million. The cost of GHG reduction is 41.5 USD/ tCO_2-eq.

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