Technology Fact Sheet for Mitigation

Technology 2: **Pumped storage Hydroelectricity** [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	**Pumped storage hydroelectricity**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Pumped storage hydro uses two water reservoirs which are separated vertically. In times of excess electricity, often off peak hours, water is pumped from the lower reservoir to the upper reservoir. When required, the water flow is reversed and guided through turbines to generate electricity. Pumped hydro is the most developed energy storage technology, with facilities dating from the 1890s in Italy and Switzerland. Currently, there is over 90 GW of pumped storage capacity in operation worldwide, which is about 3% of global generation capacity. The main applications of pumped hydro are for energy management, frequency control and provision of reserves. Pumped storage plants are characterized by long construction times and high capital expenditure. However, with rising electricity prices and increasing use of intermittent energy sources, it can be very economic to store electricity for later use http://climatetechwiki.org/category/energy-services/electricity?page=1
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The Mongolian Central Energy System can save the excess electricity generation during off-peak hours for use during peak hours, thereby achieving better demand-supply matching, reducing total electricity generation and CO_2 emissions. In Mongolia all base-load power comes from coal and off-peak generation generally also comes from coal fired power generations and imports from Russia. In the future, after construction of coal fired power plant #5, the Central Energy System probably will not import electricity from Russia because of sufficient generation capacity. The pumped storage hydroelectricity power plant will reduce GHG emissions compared to the coal fired thermal power plants. There is a feasibility study for construction of a new 100 MW pumped storage hydroelectricity power plant in Ulaanbaatar on the Tuul river prepared by Morituimpex company[1]. The feasibility study has been approved by the Government of Mongolia. According to the feasibility study the construction of a pumped storage hydro power plant will reduce coal consumption in contrast to the base line coal fired thermal power plant by 290,000 tCO_2-eq per year

[1] The feasibility study and technical specifications of the 100 MW Ulaanbaatar pumped storage hydro power plant, 2007 Ulaanbaatar

	by stopping one turbine with capacity of 100 MW that is operating in the peak period or kept in operation as hot reserve.
Reduction in GHG emissions	We can calculate CO_2 emissions. The IPCC default CO_2 emission factor for lignite coal is 101tCO_2/TJ. If we assume the average Net Calorific Value is 3500 kcal/kg then CO_2 will be reduced by 424,300 tCO_2/year (290,000*3,500*4.18/1,000,000). But the pumped storage hydroelectricity power plant consumes electricity during the off-peak period. According to the feasibility study the consumption is 254 million kWh/year. If the electricity consumption is converted to CO_2 emissions it will be 280,000 tCO_2 (254,000 MWh x1.103tCO_2/MWh)[2]. Therefore GHG emissions are expected to be reduced by 144,300tCO_2eq/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	The pumped storage hydroelectricity power plant will have two water reservoirs which can improve climate conditions by reducing the dryness of the climate and increasing humidity in Ulaanbaatar city. The two reservoirs will be used to create parks and beaches.
Economic development priorities	Energy storage can reduce costs for consumers of electricity. In general, off-peak electricity is cheaper compared to high-peak electricity. This is due to the base-load characteristics of off-peak electricity. Energy storage in the form of pumped hydro provides customers with off-peak electricity in high-peak situations. In addition to being an economic benefit to the seller of the electricity, it might also be an economic benefit to the customer when the electricity is sold at lower prices compared to the high-peak generated electricity. The pumped storage hydroelectricity power plant can reduce coal consumption in power plants and also can increase electricity reliability.
Environmental development priorities	a. Reduced air pollution: The pumped storage hydroelectricity power plant can reduce air pollution by decreasing coal consumption in power plants. b. Climate: The two water reservoirs can improve environmental conditions of Ulaanbaatar city. The two reservoirs will be used to create green belts, parks and beaches to reduce dry climate and increase humidity.
Other considerations and	

[2]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

priorities such as market potential	
Costs	
Capital costs	According to the feasibility study for the construction of pumped storage hydro power plant with capacity of 100 MW, 105 million USD is required. Assuming a life time of 20 years, the annualized cost would be around 5.25 million USD.
Operational and Maintenance costs	According to the feasibility study for the construction of a pumped storage hydro power plant with capacity of 100 MW, the operational and maintenance costs will be 17.1 million USD annually.
Cost of GHG reduction	Annual capital cost 5.25 Million USD plus O&M cost 17.1 million USD. Total cost in the year 2025 is 22.35 million USD. Mitigation achieved is 144,300 tCO_2/year. Therefore cost of GHG reduction is 154.88 USD/ tCO_2.

[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/**