

Project Profile

Hybrid Wind-Diesel System / Isolated Grid in Gao/ Mali

GTZ in co-operation with Direction National de l'Energie (DNE) of Mali has developed a wind park project as a hybrid wind diesel system integrated into an isolated grid since 2000 in Gao / northern Mali. Lahmeyer International has performed a feasibility study in 2003/2004.



Figure: Map of Mali

Key results of the Feasibility Study:

Project goal	A wind park shall be connected to an existing Diesel power station of an isolated grid. The main goal is to substitute diesel fuel, which has to be transported by trucks for more than 2500 km.
Project environment	Mali is one of the poorest countries in West Africa. Electricité de Mali (EDM) the Utility in Mali was privatised in 2000. EDM is operating the interconnected grid in the south of Mali as well as the isolated grids like in Gao.
Project site	Gao a small city of 40,000 inhabitants is located 1200 km north east of the capital Bamako on the shore of river Niger and at the south rim of Sahara desert.

Technical parameters	
Type of turbine	3 x 300 kW, 30m rotor diameter, 50 m hub height, Inverter technology, was selected because of the good electrical performance in a weak existing grid.
Alternative type of turbine	4 X 225 kW, 40 m hub height, asynchronous generator, used turbines from repowering, lower specific investment
Diesel power station	The existing power station was extended to a capacity of 4 MW.
Electricity demand	The peak load was 1,8 MW in 2003. The energy demand was about 9 GWh in 2003.
Power distribution	The mid voltage grid supplies only the city and the airport on the 15 kV level.
Grid connection of the wind park	The grid connection is planned to an existing 15 kV line at the site
Geotechnical conditions	The brief soil investigation shows a hard sandy underground, suitable for flat foundations
Transport	Road transport on asphalt roads until Gao, 1 ferry crossing (40 t)
Erection concept	1 existing crane of 160 t in Nigeria, alternatively , self erecting crane or tilt up towers
Street construction	Access roads have to be extended at a length of 2 km, flat terrain
Wind Diesel Control System	Autonomous control systems for wind and diesel. Emergency control of the wind park from the diesel power station. Remote control of the wind turbine from the manufacturer.
Load simulation	A load and generation simulation was performed on hourly values. 0,5 % of the wind energy potential can not be used due to low electricity demand. The Diesel gen sets have to be operated increasingly at partial load which will lead to a specific higher fuel consumption of 1,5 % respectively.
Operation of the wind park	The daily operation will be performed by the local team of the EDM diesel power station. The annual inspection is foreseen for the turbine manufacturer.
Wind measurements	Since 2001 measurement at 26m and 40 were performed. The average wind speed at 40 m height is 5,0 m/ s.
Wind potential	For 3 x 300 kW, the wind potential is predicted to be 1021 MWh/a as a P 75 value

Cost estimation for the wind park	
Investment	1.753.000 Euro, 27 % local, 73 % in foreign currency
Operating cost	21.650 Euro/a
Diesel electricity generation specific cost at Gao	138 FCFA / kWh = 0,21 Euro/ kWh (current tax exemption) 183 FCFA / kWh = 0,275 Euro / kWh (if tax was applied)
Cost of opportunity	121,5 FCFA / kWh = 0,183 Euro / kWh Wind power
Carbon emissions reduction	CO2 reduction of the wind park: 880 t/a. Estimated income through emissions trading 4.400 Euro / a
Economic Analysis	
Business assessment	Assumptions: <ul style="list-style-type: none"> • Useful life: 20 years • feed in tariff: 120 FCFA/ kWh = 0,180 Euro/kWh • equity rate: 20 % • foreign currency loan: interest rate 2%, 14 years credit period, 2 years grace period • local currency loan: interest rate 12%, 6 years credit period, 0 years grace period • internal rate of return on equity 10 %
Chances and risks	<ul style="list-style-type: none"> • CDM remuneration of 2 % of income was assumed • Income tax exemption was limited to 12 years. If longer period can be achieved, positive effect.
Macroeconomic analysis	<p>The quantitative analysis shows a small macro economic advantage of the project.</p> <p>The main qualitative advantages are:</p> <ul style="list-style-type: none"> • Use of local energy resources • divers sources of electricity generation • lower dependency from fuel imports • lower carbon emissions • the project support the energy politic goal of the Government of Mali • The project could have an important pilot function in the region
Chances and risks	Power substitution effects of wind power were assumed to 13% of the rated power.
Private investment	The project company shall be the shell for the investment of different shareholders. A minority equity share is foreseen for EDM to back up the operational tasks.

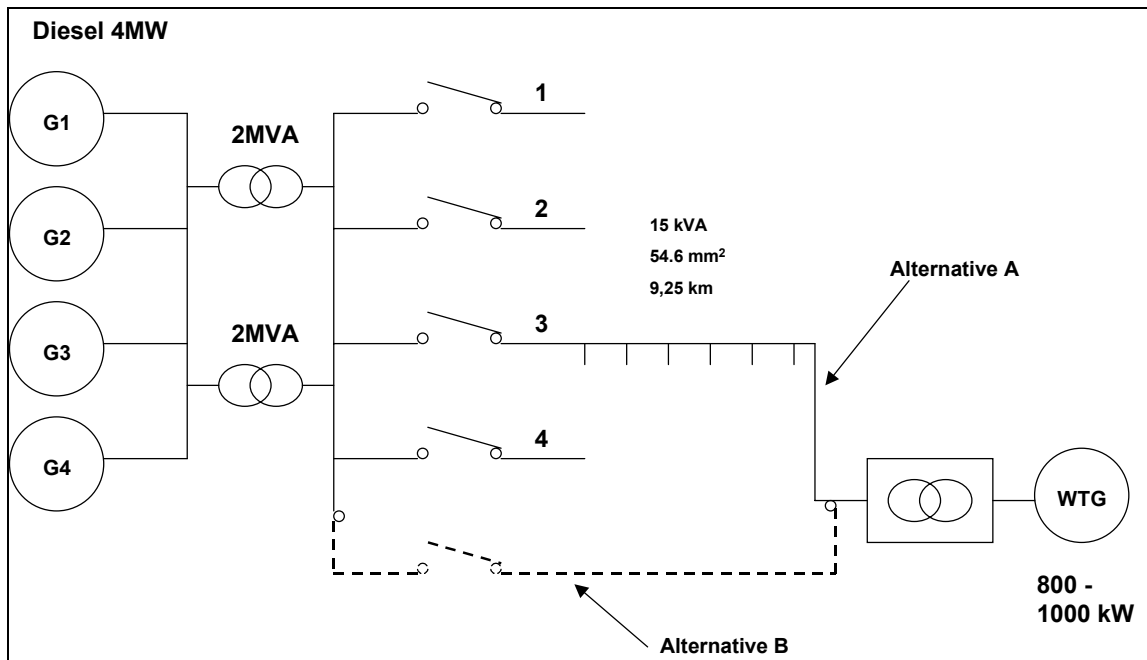


Figure: Electrical Scheme of the Wind –Diesel System



Figure: Cattle market of Touareg Nomads near Gao

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