

ห้องสมุดงานวิจัย สำนักงานคณะกรรมการวิจัยแห่งชาติ



E47351

**TECHNO - ECONOMIC ASSESSMENT OF FUTURE PERSPECTIVES OF
THE CONCENTRATED SOLAR POWER PLANT IN MONGOLIA**

TUMENJARGAL MAKHBAL

**A Thesis Submitted to the Graduate School of Naresuan University
In Partial Fulfillment of the Requirements
for the Master of Science Degree in Renewable Energy
(International Program)**

MAY 2012

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This thesis entitled “Techno-Economic Assessment of Future Perspectives of the Concentrated Solar Power Plant in Mongolia” submitted by Tumenjargal Makhbal in partial fulfillment of the requirements for the Master of Science Degree in Renewable Energy (International Program) is hereby approved.



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ABSTRACT

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This research presents a techno-economic assessment of future perspectives of the concentrated solar power plant in Mongolia. Methodology of the study is the data collection and data analyses, the technical evaluation of parabolic trough CSP plant, the economic and environmental evaluation parabolic trough CSP plant, and the recommendation for CSP technology development in Mongolia. Sainshand and Dalanzadgad cities are sited to assess the direct normal irradiation, land availability, water resources, grid connectivity and infrastructure. The technical evaluation result shows that both sites would be recommended to install the Parabolic Trough Concentrated Solar Power plant in the Gobi Desert of Mongolia.

The economic evaluation was investigated in term of the comparison between 5MW off-grid and grid connected parabolic trough solar thermal power plants in case of FIT and Tax Incentive. It showed that both CSP projects would not be economically viable at 8 % discount rate and project investment of 13.7 to 13.9 million Euro. From the government FIT policy which has already announced to the investors as maximum FIT of € 0.14/kWh, the results from this research showed that the NPV of CSP power plant is 12.7 million Euro while the BCR is 1.35 to 1.38. It is also indicates that IRR is between 6.8 to 7.04 % whereas the payback period is around 8 years. The conclusion of this research is considered to recommend to the Mongolian Government to accept new term similar to “Adder”, subsidy scheme in Thailand. This means regular

consumer energy price plus FIT. However, the Government should consider carefully in a financial model before the Government offers the new subsidy policy to the entrepreneurs CSP projects. If the Government revised Renewable Energy Law adding new policy, CSP projects such as off-grid and grid connected would be economically viable at 8 % discount rate, FIT and Tax Incentive.

This study also aims to encourage the Mongolian government and the private sector to implement the parabolic trough solar power plants for future magnification of power sector due to the increasing electricity demand and environmental degradation.

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ABBREVIATIONS

A_a	=	Aperture area
A_r	=	Receiver area
AUES	=	Altai-Uliastain Energy System
BCR	=	Benefit to cost ratio
C	=	The concentration ratio
$^{\circ}\text{C}$	=	Unit of degree Celsius
CES	=	Central Energy System
CDM	=	Clean Development Mechanism
CHP	=	Coal-fired heat power plant
CSP	=	Concentrated Solar Power
DNI	=	Direct Normal Irradiance
E	=	East
EES	=	Eastern Energy System
ERA	=	Energy Regulatory Authority of Mongolia
FIT	=	Feed-In Tariffs
G_{sc}	=	Solar constant
G_{on}	=	The extraterrestrial radiation
G_{cnb}	=	Clear sky beam radiation
HPP	=	Hydro power plant
IRR	=	Internal rate of return
km	=	Kilometer
kV	=	Kilovoltage
kWh	=	Kilowatthour
LCOE	=	Levelized costs of electricity
m	=	Meter
m^2	=	Squaremeter
m^3	=	Cubicmeter
MW	=	Migawatt
N	=	North

ABBREVIATIONS (CONT.)

NAMEN	=	National Agency for Meteorology and Environment Monitoring
NPV	=	Net present value
O&M	=	Operation and maintenance
PBP	=	Payback period
P_{elec}	=	Power output
S	=	South
t_s	=	Solar time
U_L	=	Overall Heat loss coefficient
W	=	Western Energy System
WES	=	West
α_s	=	Solar altitude angle
β	=	Slope
γ	=	Surface azimuth angle
γ_s	=	Solar azimuth angle
δ	=	Declination
η_{thermal}	=	The thermal efficiency
θ	=	Angle of incidence
θ_z	=	Zenith angle
τ_b	=	The atmosphere transmittance for beam radiation
φ	=	Latitude
ω	=	Hour angle
ω_s	=	Sunset hour angle
%	=	Percent
\$c	=	US dollarcent (currency)
€c	=	Eurocent (currency)