CLIMATE INVESTMENT FUNDS

SREP/SC.14/4
October 13, 2015

Meeting of the SREP Sub-Committee
Washington D.C.
Wednesday, November 11, 2015

Agenda Item 4

SREP INVESTMENT PLAN FOR MONGOLIA

PROPOSED DECISION

The SREP Sub-Committee, having reviewed document SREP/SC.14/4, *SREP Investment Plan for Mongolia*,

a) endorses the investment plan as a basis for the further development of the projects and programs foreseen in the plan and takes note of the request for USD 30 million in SREP funding.[1] The Sub-Committee requests the Government of Mongolia, in the further development of the proposed projects and programs, to take into account comments made at the meeting and any additional written comments submitted by Sub-Committee members by November 27, 2015, and to respond in writing to questions raised during the meeting and in subsequent written comments;

b) reaffirms that all allocation amounts are indicative for planning purposes and that approval of funding will be on the basis of high quality investment plans and projects;

c) approves USD 1 million as preparation grant for the project entitled, *Upscaling Rural Renewable Energy* (ADB);

d) approves USD 0.5 million as preparation grant for the project entitled, *Upscaling Rural Renewable Energy* (World Bank);

e) takes note of the estimated budget of USD 428,000 for MDB project preparation and supervision services for the project entitled, *Upscaling Rural Renewable Energy* (ADB), and approves USD 214,000 as a first tranche of funding for such services;

f) takes note of the estimated budget of USD 428,000 for MDB project preparation and supervision services for the project entitled, *Solar PV* (World Bank), and approves USD 128,000 as a first tranche of funding for such services;

g) further takes note of the estimated budget of USD 140,000 for MDB project preparation and supervision services for the project entitled, *Technical Assistance* (World Bank), and approves USD 70,000 as a first tranche of funding for such services.

[1] USD 300,000 in SREP funding has already been approved for the development of the investment plan.

MINISTRY OF FINANCE OF MONGOLIA

15160 S.Danzangiin gudamj 5/1,
Zasgiin gazriin II bair, Chingeltei duureg,
Ulaanbaatar, MONGOLIA
Tel/Fax:(976-51) 26-02-47, http://www.mof.gov.mn

Date 01. 10. 2015
Ref. 10-1/ 5792

Mafalda Duarte
Program Manager, Administrative Unit
Climate Investment Funds,
The World Bank
Washington D.C. USA

Dear Ms. Duarte,

Subject: SREP Investment Plan for Mongolia

It is my honor to submit the Investment Plan for Scaling-up Renewable Energy Programme (SREP) in Mongolia for consideration by the Climate Investment Fund's SREP sub-committee. The Government of Mongolia appreciates the assistance provided by the Climate Investment Fund and the technical support from the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), and the World Bank Group, to develop the SREP Investment Plan.

The Government of Mongolia recently updated the State Policy on Energy 2015-2030 which promotes energy security, affordability, efficiency, and sustainability. The policy and regulatory framework calls for 20% of increasing power capacity to come from renewable resources by the year 2023, increasing to 30% by the year of 2030. These targets are consistent with advanced economies, and appear to be achievable based on abundant renewable resources which are mostly solar and wind.

However, Mongolia faces some challenges that are quite different from other countries, in particular the critical need for heating services for about 8 months per year: in effect, the energy sector is built around heating services, and combined heat and power plants are fueled by abundant indigenous coal. Thus, coal will remain a fundamental part of the energy mix and renewable energy development will require incentives for the foreseeable future in order to achieve parity with coal. Integrating variable output from solar and wind plants presents an additional technical challenge that will require development of large-scale hydropower resources and/or new cross-border grid connections.

Consequently, achieving the long-term energy sector and potential economic transformation will require immense sustained investment per year, for above current public and private sector investment level. At this stage SREP co-financing appears quite limited compared to long-term investment needs, but can provide a significant level of support to begin initiating the transformation. Given the technical challenges and the country's current fiscal situation, we would like the SREP Sub-committee to consider providing all SREP funds as full grant bases.

Considering the current renewable energy development status, and the overall SREP objectives for promoting renewable energy capacity and output, access to energy, and productive and use of energy, we believe that limited SREP resources should be directed towards projects in less developed regions which are not attractive to private sector developers and investors, and to projects which may be less commercial in the near term but have large replication and scale-up potential.

In this regards, based on the overall experience to date and the various challenges outlined above, the Investment Plan proposes to utilize the limited SREP resources to a phased 2-track approach, with most funds utilized in learning-by-doing investment activities (Track 1) complemented by technical assistance for capacity building and policy evolution (Track 2). The medium-long-term result will be an improved and expanded foundation for aggressive replication and scale up of renewable energy development. The proposed investments include solar and wind installations in the western region that will account for around 70% of the local grid capacity, which is well above the business as usual scenario, and shallow ground heat pumps for every low-emissions heating services. The investments are replicable and scalable, and the experience gained in Mongolia can be transferred to other countries.

The Investment Plan has been developed with extensive consultations with relevant government agencies, development partners, the private sector, and other stakeholders who have expressed support for the proposed scope of activities. The Government of Mongolia looks forward to endorsement of this Investment Plan, and looks forward to working with the CIF's and development partners to successfully implement the envisaged investments and advisory services which will begin the transformation to a sustainable energy future.

Sincerely,

Kh.Gantsogt
State Secretary

GOVERNMENT OF
MONGOLIA

SCALING-UP RENEWABLE ENERGY PROGRAMME (SREP)

Investment Plan for Mongolia

October 2015

CONTENTS

EXECUTIVE SUMMARY		**iv**
I.	**COUNTRY CONTEXT**	**1**
A.	Geography	1
B.	Population	1
C.	Political Administration	1
D.	Climate Change	2
E.	Energy Sector Institutional Structure	3
F.	Energy System Administration	4
G.	Electricity and Heat Sector Ownership	5
II.	**RENEWABLE ENERGY SECTOR CONTEXT**	**7**
H.	Renewable Energy Options	7
a)	Wind	7
b)	Solar	8
c)	Hydropower	9
d)	Geothermal	11
e)	Ground Heat Pumps with Solar / Wind	11
I.	Costs of Renewable Energy	12
J.	Barriers to Commercial Renewable Energy	13
III.	**CONTRIBUTION TO THE NATIONAL ENERGY ROADMAP**	**16**
K.	Meeting National RE Capacity Targets	16
IV.	**SREP PROGRAM DESCRIPTION**	**19**
L.	Phase 1 - Track 1: Upscaling Rural Renewable Energy	20
M.	Phase 1 - Track 2: Strengthening Renewable Energy Regulations	22
V.	**FINANCING PLAN AND INSTRUMENTS**	**25**
VI.	**RESPONSIVENESS TO SREP CRITERIA**	**27**
VII.	**IMPLEMENTATION POTENTIAL WITH RISK ASSESSMENT**	**30**
VIII.	**MONITORING AND EVALUATION**	**31**

LIST OF ANNEXES

ANNEX A. ASSESSMENT OF COUNTRY ABSORPTIVE CAPACITY 32
ANNEX B. EXISTING ACTIVITIES IN THE FIELD OF RENEWABLE ENERGY 40
ANNEX C. SUMMARY OF STAKEHOLDER CONSULTATION 47
ANNEX D. RENEWABLE ENERGY CURTAILMENT 51
ANNEX E. ASSUMPTIONS USED IN ESTIMATING LEVELISED ENERGY COSTS 66
ANNEX F. CO-BENEFITS 70
ANNEX G. PROJECT CONCEPT NOTES 72
ANNEX H. INDEPENDENT QUALITY REVIEW 86

ABBREVIATIONS

ADB	–	Asian Development Bank
AuES	–	Altai Uliastai Energy System
CES	–	Central Energy System
CHP	–	Combined Heat and Power
CO_2	–	Carbon Dioxide
DES	–	Dalanzadgad Energy System
EA	–	Executing Agency
EES	–	Eastern Energy System
ERC	–	Electricity Regulatory Commission
FiT	–	Feed-In-Tariff
GDP	–	Gross Domestic Product
GHG	–	Greenhouse gas
GoM	–	Government of Mongolia
MDB	–	Multilateral Development Bank
MOE	–	Ministry of Energy
NDC	–	National Dispatching Center
NREC	–	National Renewable Energy Center
NREL	–	National Renewable Energy Laboratory
TA	–	Technical Assistance
UB	–	Ulaanbaatar
WACC	–	Weighted Average Cost of Capital
WB	–	World Bank
WES	–	Western Energy System
WRES SOJSC	–	Western Region Energy System State-Owned Joint Stock Company

WEIGHTS AND MEASURES

kVA (kilovolt-ampere)	– 1,000 volt-amperes
kWh (kilowatt-hour)	– 1,000 watts-hour
W (watt)	– unit of active power
kW (kilowatt)	– 1,000 watts
MW (megawatt)	– 1,000 kilowatts
GW (gigawatt)	– 1,000,000 kilowatts

NOTE

In this report, “$” refers to US dollars.

EXECUTIVE SUMMARY

1. The Scaling-up Renewable Energy in Low-income Countries Programme Investment Plan (SREP IP) will support the Government of Mongolia (GoM) in comprehensively addressing the country's renewable energy potential by supporting physical investments and implementing policy actions to create an enabling environment for sustained public and private investments. The SREP IP is part of the government's comprehensive plan which is expected to facilitate development of 20% of the renewable energy target for year 2023 and 30% by year 2030.

2. The objectives of the IP are: 1) to support upscaling of rural renewable energy by demonstrating the application of 25 megawatt (MW) wind and solar photovoltaic (PV) resources in a remote rural area of Mongolia; and 2) to encourage private sector investment in utility-scale renewable energy by improving aspects of the governing regulations in force in Mongolia.

3. The SREP IP will support the development of the local capacity crucial for the scale-up of renewable energy technologies after SREP and donor funding has been expended. Furthermore, the demonstration effect of projects receiving funding will serve to educate consumers on the benefits of renewable energy technologies.

4. An indicative financing plan is given below as Table ES-1 and an output-based results framework as Table ES-2.

Table ES-1: Indicative Financing Plan

(US$ million)

	Private Sector	SREP			MDB[a]		GoM	TOTAL
		Total	ADB	WB	ADB	WB		
Investment Plan Components								
PHASE 1 - TRACK 1: Upscaling Rural Renewable Energy								
1. Solar PV power plants 2x10 MW	-	24.8	12.4	12.4	11.4	11.4	1.0	48.6
2. Wind energy plant 1 X 5 MW	-	-	-	-	11.5	-	0.5	12.0
3. Small hydropower development X 1	-	1.2	1.2	-	-	-	0.1	1.3
4. Shallow Ground Heat Pumps x 5	-	1.0	1.0	-	-	-	0.1	1.1
5. Technical assistance	-	1.5	1.0	0.5	-	-	0.2	1.7
Subtotal	**-**	**28.5**	**15.6**	**12.9**	**22.9**	**11.4**	**1.9**	**64.7**
PHASE 1 - TRACK 2: Strengthening Renewable Energy Regulations								
6. Technical assistance for ERC and NDC	-	1.2	-	1.2	-	-	0.1	1.3
Subtotal	**-**	**1.2**	**-**	**1.2**	**-**	**-**	**0.1**	**1.3**
PHASE 1 TOTAL		**29.7**	**15.6**	**14.1**	**22.9**	**11.4**	**2.0**	**66.0**
PHASE 2								
7. Scale up / replication in WES and AuES (20 MW)	tbd	-	-	-	35.0	-	3.5	38.5
8. Scale up / replication in EES (30 MW)	tbd	-	-	-	42.1	-	4.2	46.3
PHASE 1 and 2 TOTAL	**tbd**	**29.7**[b]	**15.6**	**14.1**	**100.0**	**11.4**	**9.7**	**150.8**

ADB = Asian Development Bank, AuES = Altai Uliastai Energy System, EES = Eastern Energy System, ERC = Energy Regulatory Commission, GoM = Government of Mongolia, MDB = multilateral development bank, MW = megawatt, NDC = National Dispatching Center, PV = photovoltaic, tbd = to be determined, WB = World Bank, WRES = Western Region Energy System.

Notes:

[a] Financing by MDBs may be provided as either loan or grant (or both) depending on Mongolian government decision for utilizing country allocation of respective agencies.

[b] Excludes IP preparation grant of US$ 0.3 million.

Source: Ministry of Energy.

Table ES-2: Results Framework

Results	Indicators	Baseline	Targets	Means of Verification
SREP Transformative Impacts				
Support low carbon development pathways	RE capacity (MW) and annual electricity output (GWh/y) of hydro <10MW	Capacity: 50 MW [a] Output: 120 GWh/y [a]	Capacity: 630 MW by 2023; 1085 MW by 2030 Output: 1 200 GWh/y by 2023; 2 400 GWh/y by 2030	Ministry of Energy
	Increased annual public and private investments (US$) in targeted subsector(s)	$110million [b]	> $ 350 million[c] by 2023 $ 1 billion by 2030	Ministry of Energy
SREP Program Outcomes				
1. Increased supply of renewable energy	Annual electricity output from RE as a result of SREP interventions			SREP Projects M&E Framework
	Installed capacity	0	25 MW	
	Output	0	40 GWh/y	
2.New and additional financing sources for renewable energy projects	Leverage factor (US$ finance from other sources compared to SREP funding)	0	1.2 [d]	SREP Projects M&E Framework

GWh/y = gigawatt-hour per year, M&E = monitoring and evaluation, MW = megawatt, RE = renewable energy, SREP = Scaling-up Renewable Energy for low-income countries Programme.

Notes:

[a] Salkhit Wind Farm, SHS, small hydro; does not include hydro > 10MW

[b] Assumes $2.2 / watt installed cost for Salkhit wind farm. Does not include existing SHS or small hydro.

[c] Assumes Sainshand, Tsetsii and Choir windfarms as committed, WES 25MW supported by SREP; estimated at $2.2 / watt installed cost.

[d] When Phase 2 investments (scaling up and replication) are included, the leverage ratio would be 4.1.

Source: Ministry of Energy estimates.

I. COUNTRY CONTEXT

A. Geography

5. Mongolia is a land-locked country located in the central part of Asia. The climate of Mongolia is continental, and has four distinct seasons. The winter climate is extremely harsh with winter daytime temperatures ranging from -10°C to -30°C (late December and January). Temperatures can drop to as low as -40°C at night. The heating season is unusually long at eight months and as a consequence a reliable heating service is not merely a utility for citizens; it is literally a matter of life and death. A safe, clean, and reliable heating supply is a critical need for the entire population of Mongolia.

Figure 1: Map of Mongolia

B. Population

6. Mongolia had an estimated population of 2.84 million in 2014. Ulaanbaatar (UB), the capital city of Mongolia, is the coldest capital city in the world. It is the political, economic and cultural center of the country. The population of UB accounted for around 42% of the total, increasing from 1.01 million in 2009 to 1.19 million in 2014 mainly due to rural population movement.

C. Political Administration

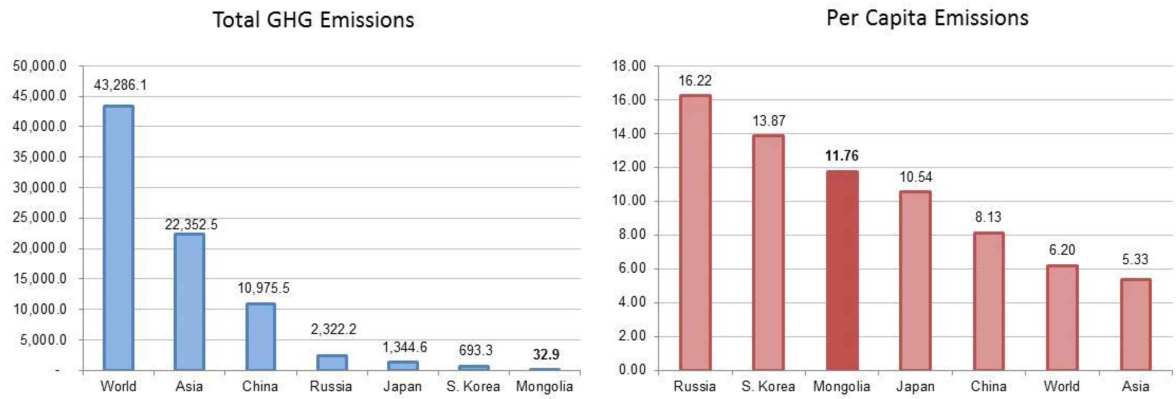
7. Mongolia is divided into 21 aimags (provinces) and three municipalities of UB, Darkhan and Erdenet. Each province and municipality is empowered by statute to establish a local government body responsible for directing economic and cultural-political development, for supervising the economic organizations and 'co-operatives', for confirming and implementing the government's economic plan and local budgets, for ensuring the observance of laws, and for making certain that all citizens are fully involved in the work of the state. Each province is further divided into soums (districts) of which there are 329 in total. The soums are second level administrative precincts populated by around 5,000 nomadic herder families each. A further sub-division of the soum precincts are known as 'bags'.

D. Climate Change

8. Based on scientific studies, Mongolian climate has already changed significantly these include increase in annual mean temperature by about 2.1°C during the period of 1940–2007; increase in duration of heat waves by 8-18 days depending on geography; and alteration in annual precipitation (regardless of increasing or decreasing) by 5-25%. Studies concluded that climate change and global warming will have a significant impact on natural resources such as water resources, natural rangeland, land use, snow cover, permafrost, major economic activity of arable farming, livestock, and society (i.e. human health, living standards, etc.) of Mongolia. It may worsen existing natural resource concerns, such as diminution of water resources and desertification. The pastoral population being dependent on grasslands and water resources for livelihood are among the most vulnerable groups to its impacts because of the loss of livestock, malnutrition, and exposure.

9. Mongolia's contribution to global greenhouse gas (GHG) emission is relatively low. Total GHG emissions excluding land use and forestry were 32.88 million tons of carbon dioxide equivalence ($MtCO_2e$) in 2012, representing 0.07% of the world total.[1] However, its annual per capita emission of GHG in CO_2-equivalent is relatively high compared to other countries. The country's per capita emissions were 11.76 tons per person, which is almost two times than world average.

Figure 2: Country and per Capita GHG Emissions (excluding LUCF), 2012
($MtCO_2e$)

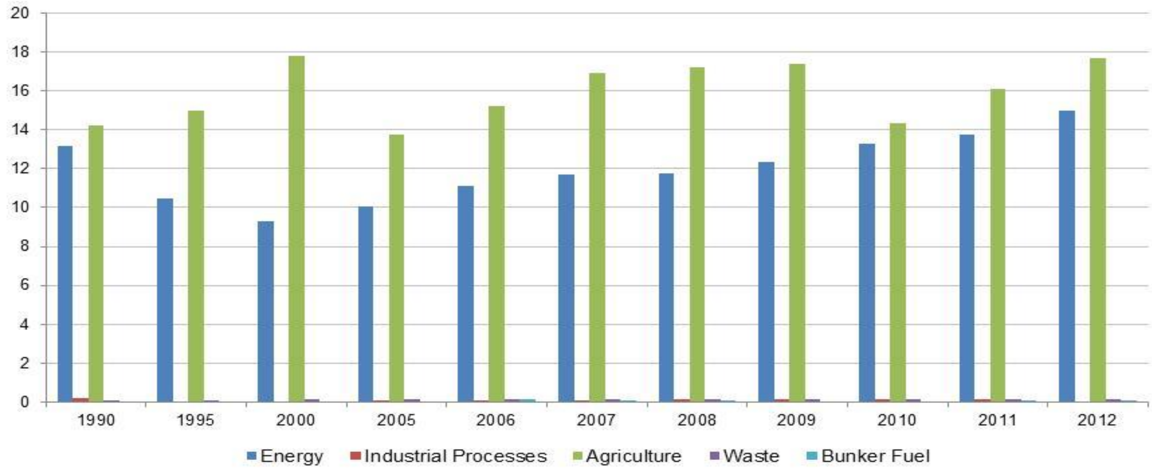


GHG = greenhouse gas, LUCF = land use change and forestry, MtCO2e = million tons carbon dioxide equivalence.
Source: CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute.

10. Mongolia's largest contributor to GHG emissions is the energy sector, as shown in Figure 3 below. Among energy sub-sectors, electricity and heating constitutes the largest share of these emissions. The analysis of GHG emissions by fuel type for the period 1993-2020 indicates that coal will be the predominant source of CO_2 emissions. According to the projection, CO_2 emissions from heat and electricity generation will be 6.5 times the 1993 base year level by year 2020.[2]

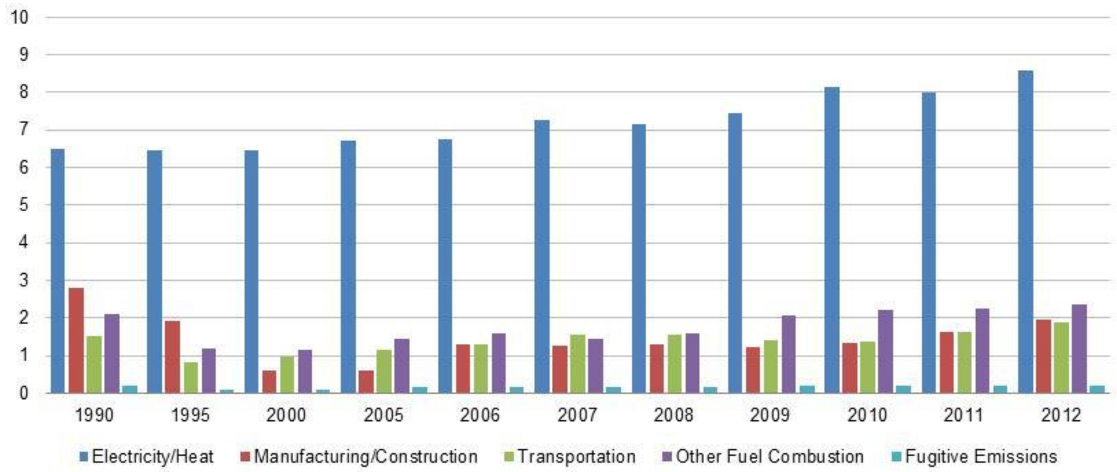
[1] Source: cait.wri.org/profile/Mongolia; Mongolia ranks #84 in terms of national GHG emissions.
[2] Source: http://unfccc.int/resource/docs/natc/mongnc1.pdf

Figure 3: Mongolia GHG emission by sector (excluding LUCF), 1990-2012
($MtCO_2e$)



GHG = greenhouse gas, LUCF = land use change and forestry, MtCO2e = million tons carbon dioxide equivalence.
Source: CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute.

Figure 4: Mongolia GHG emission Energy Sub-sector (excluding LUCF), 1990-2012
($MtCO_2e$)



GHG = greenhouse gas emissions, LUCF = land use change and forestry, MtCO2e = million tons carbon dioxide equivalence.
Source: CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute.

E. Energy Sector Institutional Structure[3]

11. The Ministry of Energy (MOE) is a line ministry in charge of policy making for the sector. The policy areas under the Ministry of Energy include the development of energy resources, energy use, the import and export of energy, the construction of power plants, lines and networks, energy conservation, the use of renewable energy sources, the monitoring of the sector, the approval of rules and regulations for the sector and international cooperation.

12. The Electricity Regulatory Commission (ERC) is an independent regulation authority, nominated by the government and self-funded by the license fees, in charge of the regulation of the generation, transmission, distribution, dispatching and supply of energy (including the licensing

[3] Source: http://www.energycharter.org/fileadmin/DocumentsMedia/ICMS/ICMS-Mongolia_2013_en.pdf

and setting of tariffs in the electricity and heating sectors). Among other responsibilities the ERC engages in dispute settlement between licensees and consumers in accordance with its jurisdiction. One of the main objectives of the ERC is to implement the transformation of the energy sector of Mongolia into a market-oriented system.

13. The National Renewable Energy Corporation (NREC) is a state-owned enterprise that has been managing scientific research, experimental and construction works, trade and the production of renewable energy equipment activities for the purposes of assessing renewable energy resources such as solar, wind, hydro, biomass and geothermal energy in Mongolia and its efficacious utilisation, since 1989. The mission of the NREC is to ensure sustainable, smooth and balanced economic and energy development through the utilization of ecologically clean renewable energy.

14. The National Dispatching Center (NDC) of Power Systems is responsible for the safe, reliable and efficient operation of the interconnected electric power system. The NDC's responsibility under certain network codes is to comply with dispatch arrangements for the reliable and stable operation of the network and electricity and heat supply using a least-cost principle to consumers 24 hours a day that meet the standards and, moreover, to maintain a balance with electricity and heat supply and demand.

F. Energy System Administration

15. The electric power network of Mongolia comprises five main energy systems. The Central Energy System (CES), which in Figure 5 is shown to include the Dalanzadgad Energy System (DES) in the South Gobi, is the largest. The smaller energy systems are the Western Energy System (WES), the neighbouring Altai-Uliastai Energy System (AuES), and the Eastern Energy System (EES). With the exception of the WES, delineated by a mountain range, the other energy systems were created historically around coal supply zones.

Figure 5: Energy Systems

16. The WES and CES are interconnected with Russia and are heavily dependent on imported

energy. There are small capacity cross-border inter-connections with China at the border areas of Hovd and Omnogobi (South Gobi) provinces.

17. The CES is supplied by five Combined Heat and Power (CHP) plants, covering the main cities of UB, Darkhan, Erdenet and 13 provinces. The nominal electric capacity in the CES is 824 megawatt (MW), however, the power plants are aged and unreliable and the available capacity is only 615 MW. The Salkhit windfarm (50 MW) is connected to the CES grid.

Table 1: Summary of CHP Plant Capacities

Plant	**Nominal Electric Capacity** (MW)
CHP 2	24
CHP 3	148
CHP 4	580
Darkhan	48
Erdenet	36
Total	**824**

CHP = combined heat and power; MW = megawatt.

18. The WES comprises three provinces of Bayan Ulgii, Khovd and Uvs. The peak demand in 2014 was reported as 32 MW. Total energy consumption was 130 gigawatt-hour (GWh). Energy was imported from Russia and China with 106 GWh and 1.7 GWh, respectively. The 12 MW Durgun hydropower plant in Khovd province generated 39 GWh.

19. The AuES serves the Gobi-Altai and Zavkhan Aimags. Demand in 2014 was reported as 14.4 MW. The AuES includes hydropower plants Taishir, Bogd gol, Tosontsengel, Guulin, Tsetsen Uul and Zavhan Mandal. The capacity of Taishir hydro power plant is 11 MW but at the present time, due to water shortage, the plant produces between 3.5 and 4.1 MW and generates around 12.4 GWh per annum.

20. The DES serves the Umnugobi Aimag. The system is very small producing with less than 5 MW of electricity in 2014. The 6 MWe Dalanzadgad CHP supplies heat and power to the town of Dalanzadgad.

21. The EES serves the Dornod, Sukhbaatar and Khentii Aimags. The system has limited electricity supply, with the 36 MWe CHP at Choibalsan as the only local source of power.

G. Electricity and Heat Sector Ownership

22. The electricity sector is owned and operated mainly by commercialized state-owned enterprises (SOEs). There are a multitude of power and heat generation, transmission and distribution companies.

Table 2: Electricity, Heat and Company Ownership Status, 2015

Energy System	**Sector**	**Company Name**	**Company ownership**
UB	Energy generation	CHP2 SOJSC	State-owned JSC
	Energy generation	CHP3 SOJSC	State-owned JSC
	Energy generation	CHP4 SOJSC	State-owned JSC
	Energy generation	Nalaikh HS SOJSC	State-owned JSC
	Power transmission & imports	NETransNetwork SOJSC	State-owned JSC

Energy System	Sector	Company Name	Company ownership
	Power distribution & sales	UB EDN SOJSC	State-owned JSC
	Power distribution & sales	Nolgo LLC	Private LLC
	Power distribution & sales	Erchim Suljee LLC	Private LLC
	Power distribution & sales	JV UB Railway	Mongolian & Russian JV
	Heat distribution & sales	UB DHN SOJSC	State-owned JSC
CES	Energy generation	Darkhan CHP SOJSC	State-owned JSC
	Energy generation	Erdenet CHP SOJSC	State-owned JSC
	Energy generation	Baganuur HS SOJSC	State-owned JSC
	Power distribution & sales	Darkhan-Selenge EDN SC	Private JSC
	Power distribution & sales	Erdenet-Bulgan EDN SOJSC	State-owned JSC
	Power distribution & sales	Baganuur & South East Regional EDN SOJSC	State-owned JSC
	Power distribution & sales	Bayankhongor Erchim EDC LLC	Locally owned LLC
	Power distribution & sales	Khuvsgul Erchim LLC	Locally owned LLC
	Power distribution & sales	Erdenet-Amidral LLC	Locally owned LLC
	Heat distribution & sales	Darkhan DHN SOJSC	State-owned JSC
WES	Power transmission & imports	WRES SOJSC	State-owned JSC
AuES	Power distribution & sales	Altai Uliastai ES SOJSC	State-owned JSC
EES	Energy generation	EES SOJSC	State-owned JSC
	Power distribution & sales		
	Heat distribution & sales		
Dalanzadgad	Energy generation	Dalanzadgad SOJSC	State-owned JSC
	Power distribution & sales		
	Heat distribution & sales		

AuES = Altai Uliastai Energy System, CES = Central Energy System, CHP = combined heat and power, EDN = Electricity Distribution Network, EES = Eastern Energy System, JSC = Joint Stock Company, LLC = limited liability company , WRES SOJSC = Western Region Energy System State-Owned Joint Stock Company, UB = Ulaanbaatar.

23. In the electricity generation sector, the only private sector operator is the Salkhit windfarm. It is the country's first independent power producer (IPP). The transmission companies are state-owned. Three of the electricity distribution companies have been privatized.

24. The heating sector in CES is organized in a similar manner so that the formerly vertically integrated utilities have been spun off to heat production, transmission and distribution SOEs. In the aimags there is a mixture of private and state-owned companies providing heat.

25. The ERC, as sector regulator, oversees a Single Buyer Model (SBM) electricity market in the CES. Six generating companies sell electricity at regulated prices[4] to 12 distribution companies via a Single Buyer (the National Power Transmission Grid Company acts as the single buyer / market operator).

[4] Retail tariffs are currently not sufficient for full cost recovery.

II. RENEWABLE ENERGY SECTOR CONTEXT

26. Mongolia has significant indigenous renewable energy resources and an educated workforce with extensive scientific and engineering expertise. Furthermore, the Government has taken proactive steps in recent years to craft laws and regulations designed to reform the power sector to enable private sector involvement in renewable energy technology development. However, Mongolia's renewable energy sector faces a number of important barriers to renewable energy deployment, primarily related to the availability of financing, the regulatory framework for renewable energy, the high cost of renewable energy technologies and public awareness of the potential benefits of renewable energy technologies

H. Renewable Energy Options

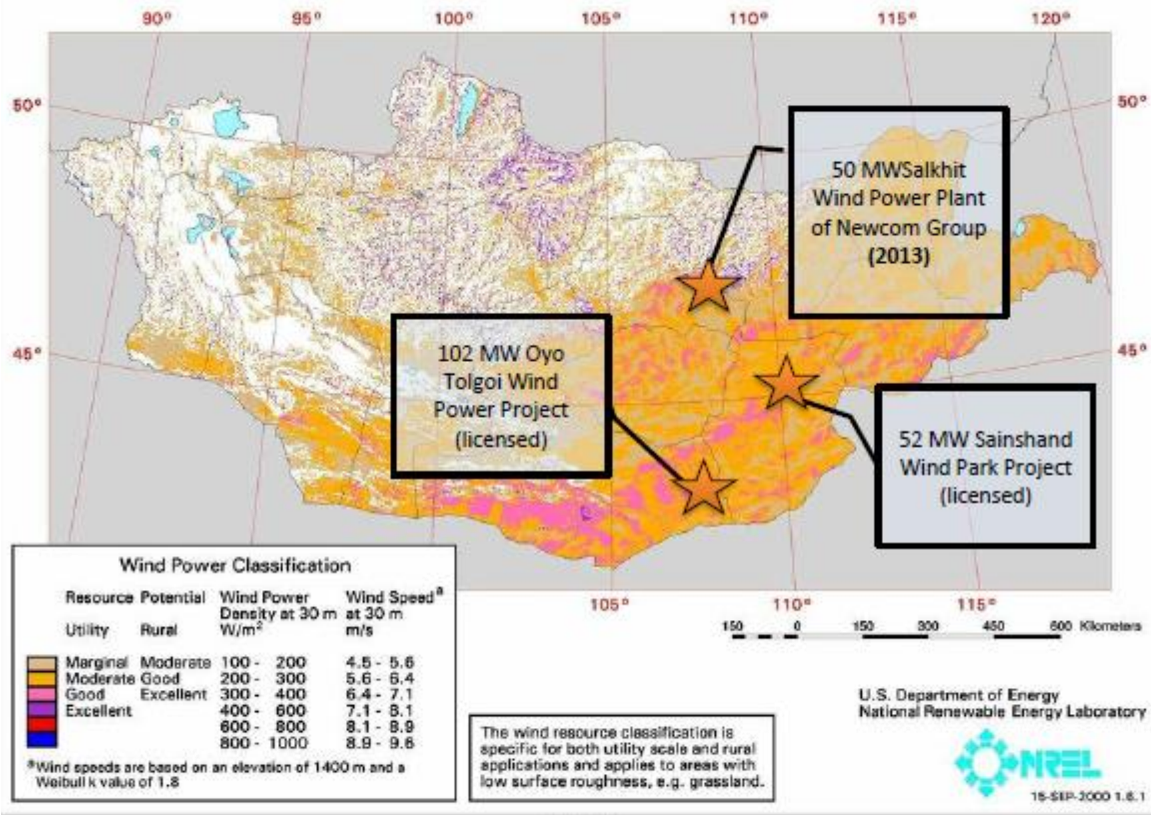
27. The total potential of Mongolian renewable energy including wind, solar, geothermal, and hydro resources is estimated by the National Renewable Energy Laboratory (NREL) of the United States Department of Energy to be as high as 2,600 GW. The Gobi Desert in particular, has tremendous renewable energy potential and has favorable climatic and weather conditions to use these resources effectively.

a) Wind

28. The distribution of annual average wind resources in Mongolia varies considerably and is controlled by several factors. The primary factor influencing wind resource potential is the westerly jet stream flowing several kilometers above sea level and its interaction with the topography of the country, such as the large mountain ranges in western and central Mongolia and the plains in the south.

29. Exposed ridge-top locations in north-central Mongolia have the highest wind resource levels in the country because they are exposed to the strong jet stream. At these sites, wind power density can be greater than 600 watt per square meter (W/m^2); however, these areas are scattered throughout mountainous regions making it difficult to take advantage of wind resources due to infrastructure limitations. The distribution of wind resources in the valleys, plains, and basins in the western region varies, with few areas of good-to-excellent wind resource potential. The areas with the best wind resources are the plains of Unugovi, Dundgovi, Dornogovi, and Sukhbaatar, all more or less located in the South Gobi region. Figure 6 identifies the wind characteristics and distribution of wind resources across the country. The map displays completed and licensed utility scale projects, which are currently under development.

Figure 6: Wind Resources in Mongolia



30. More than 160,000 square-kilometers (km^2) of land area in Mongolia, or 10% of total land area, has been estimated to have good-to-excellent wind potential for utility-scale applications (power density of 400-600 W/m^2). According to conservative assumptions made by NREL, at a capacity rate of 7 MW per km^2 this area of Mongolia has the potential to support more than 1,100,000 MW of installed capacity, and potentially deliver over 2.5 trillion kWh per annum, or 12% of global electricity consumption in 2009.[5]

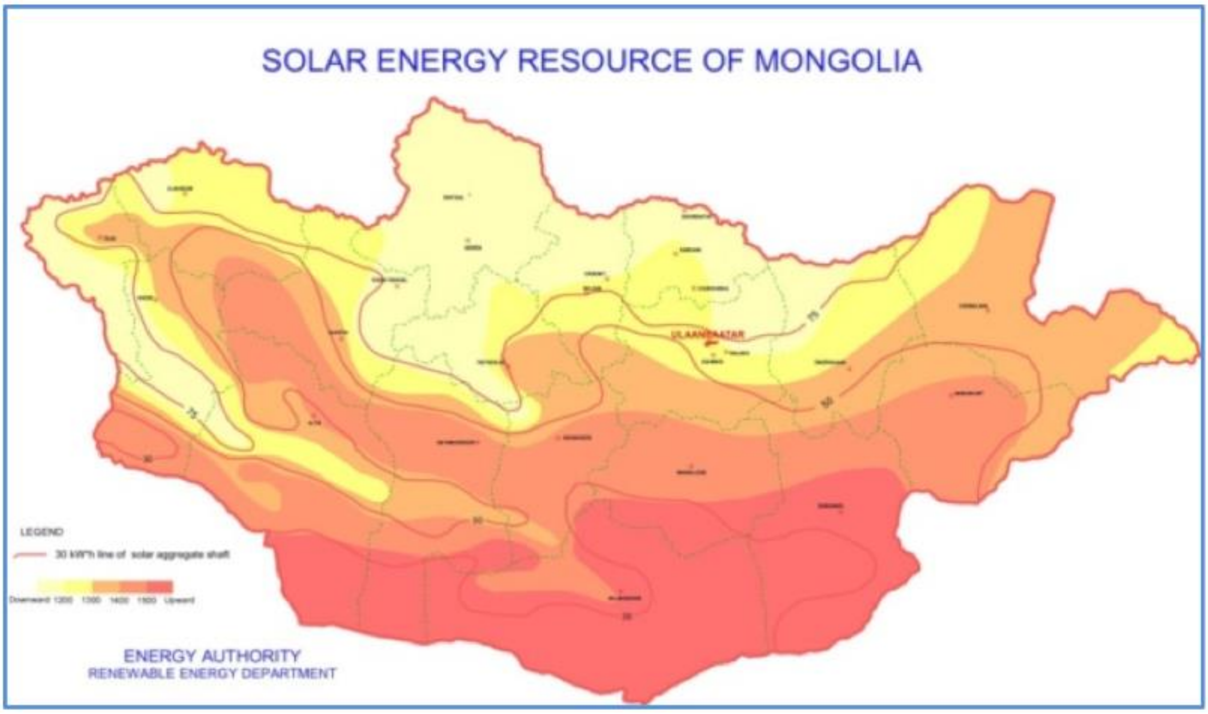
31. To date the only large scale wind project developed in Mongolia has been the 50 MW Salkhit wind farm located 70km from Ulaanbaatar. Wind farms are under development in Sainshand (52 MW), Tsetsii (50 MW) and Choir (50 MW). In addition to these large projects, there are more than 4,000 small-scale wind turbines used by herders in rural areas.

b) Solar

32. Mongolia has enormous solar resource potential, particularly in the South Gobi region. The number of sunny days averages 270 to 300 days per year, corresponding to 2,250 to 3,300 sunshine hours. Annual solar radiation is estimated to be 1,200 to 1,600 kW per m^2 and intensity is estimated at more than 4.3 to 4.7 kW per hour. More than two-thirds of the country receives high levels of incoming solar radiation in the range of 5.5 to 6.0 kWh/m^2 per day.

[5] International Energy Association: Global Electricity Consumption

Figure 7: Solar Energy in Mongolia



33. According to NREL, the solar energy potential is 1,500 GW. According to their estimates, Mongolia can, on average, produce 66 MW/km^2 from solar energy for a production of 4,774,000 GWh per annum.

Table 3: Solar Power – Intensity and Land Area in Mongolia

Estimated kWh/ m^2/day	**Applicable land** (km^2)	**Total Power** (GWh/year)
3.4	5,269.5	654,000
3.8	3,924.7	544,000
4.1	4,210.6	630,000
4.5	4,514.8	742,000
5.4	5,541.9	1,092,000
TOTAL	**23,461.5**	**4,774,000**

GWh = gigawatt-hour, Km = kilometer, kWh = kilowatt-hour, m^2 = meter square.

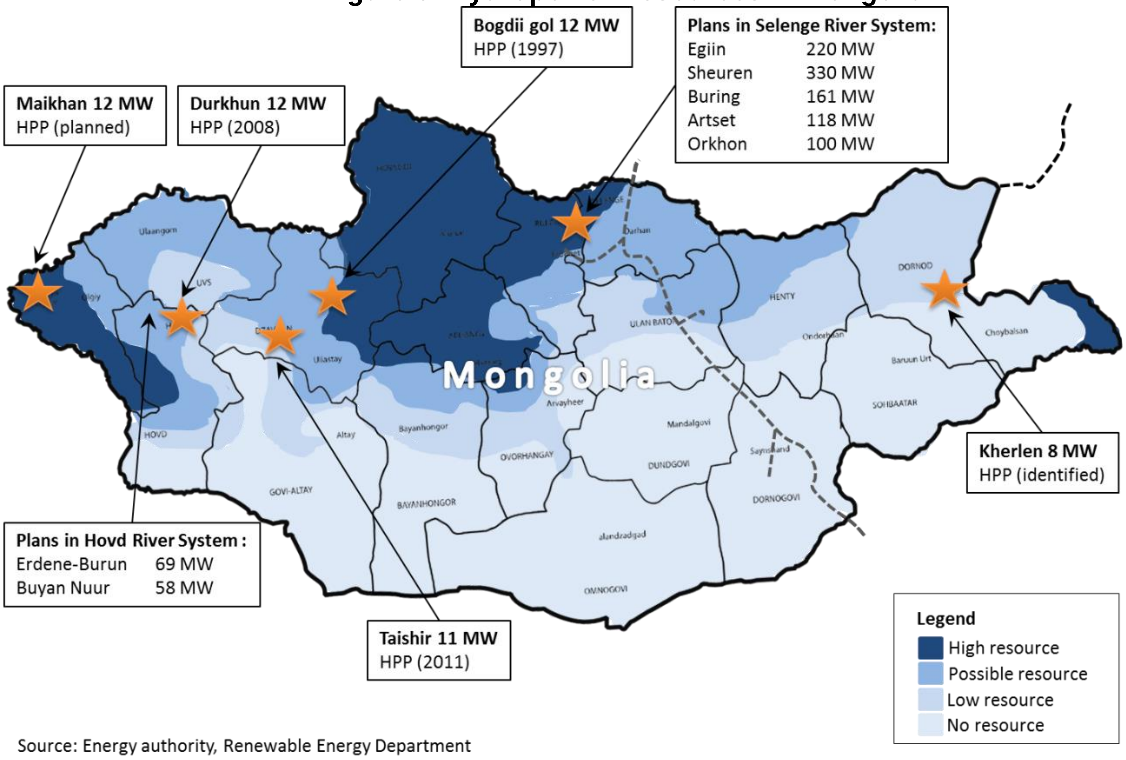
34. Despite the success of small scale solar PV systems supplying nomadic herders, there are currently no large-scale grid connected solar PV projects in the country. Several utility-scale grid-connected solar PV projects are planned and under development by the private sector. Solar district heating is being pilot-tested in a few locations. Although solar radiation levels are not at levels typical for concentrated solar power (CSP), there is potential to integrate concentrating solar thermal systems with district heating and possibly for industrial applications.

c) Hydropower

35. There is significant potential in Mongolia for hydropower generation that is, as of yet, almost entirely untapped. In 1994, the Institute of Water Policy of Mongolia estimated the gross theoretical hydropower production capacity for all rivers with a runoff of more than 1 cubic meter per second (m^3/s) at 6,400 MW, delivering a potential 56.2 million MWh of electricity per year. According to the Ministry of Green Development Water Management Report published in 2013, the actual hydropower potential is between 20% to 60% of this estimate, i.e. between 1,280 MW and 3,840 MW.

36. Figure 8 shows the hydropower resources in Mongolia. Hydropower resources are found in the Altai ranges, Tagna and Khan Khukhii ranges, and in the mountainous areas of Khuvsgul, Khangai, Khentii and the Khalkh Gol river.

Figure 8: Hydropower Resources in Mongolia



HPP = hydropower plants, MW = megawatt.
Source: Energy Authority, Renewable Energy Department.

37. There are 13 hydropower stations in Mongolia, of which nine are currently operational. There are three large and ten small hydropower plants (HPP) with a total capacity of 28 MW. The large plants are connected to local grids while the others serve isolated grids of soums. Only Taishir and Durgun operate year-round, while the small HPPs operate during the summer season only. A number of the smaller plants are no longer operational due to equipment failure.

Table 4: Existing Small Hydropower Plants in Mongolia

Name of HPP	**Aimag**	**River**	**Year**	**Installed Capacity** (kW)	**Annual Energy Production** (million, kWh)
Zavkhan Mandal	Zavkhan / AuES	Galuutai	2009	110	-
Tsetsen Uul	Zavkhan / AuES	Khungui	2009	150	-
Taishir	Gobi-Altai / AuES	Zavkhan	2008	11,000	37.0
Durgun	Khovd / WES	Chono-Kharaikh	2008	12,000	38.7
Tosontsengel	Zavkhan / AuES	Ider	2006	375	22.0
Erdenebulgan	Khuvsgul / CES	Eg	2006	200	4.4
Guulin	Gobi-Altai / AuES	Zavkhan	1998	400	0.9
Bogdiin Gol	Zavkhan / AuES	Gogdiin Gol	1997	2,000	6.0

Name of HPP	Aimag	River	Year	Installed Capacity (kW)	Annual Energy Production (million, kWh)
Not Operational					
Uench	Khovd / WES	Uench	2006	960	1.5
Kharkhorin	Ovorkhangai / CES	Orkhon	1959	528	1.1
Jigj	Uvs / WES	Jigj	1989	200	0.4
Mankhan	Khovd / WES	North Tsenker	1998	150	0.4
Munkhkhairkhan	Khovd / WES	Tsenker	2003	150	0.4
Total				**27,963**	**113**

AuES = Altai Uliastai Energy System, CES = Central Energy System, HPP = hydropower plants, kWh = kilowatt-hour, WES = Western Energy System.

38. In recent years, hydropower development in Mongolia has been focused mainly on the development of a large scheme of several hundred megawatts. Such a scheme is considered necessary to Mongolia to regulate daily power production in the CES instead of continuing to rely on Russia. Otherwise there are no known small HPP developments considered as viable by the Ministry of Energy's licensing team.

d) Geothermal

39. Comprehensive studies on geothermal resources and their potential uses have not been carried out in Mongolia, and so the economic potential of geothermal resources is unclear. However a geophysical survey conducted by the Ministry of Agriculture and Industry in the early 1990s found the following regions with geothermal potential: Mongolian Altai mountainous region: 54±24 mW/ m^2, Khangai mountainous region: 52±6 MW/ m^2, Khuvsgul lake region: 80±10 MW/m^2, East Mongolian steppes: 44±6 MW/m^2.[6] Within these regions there are 40 known sites with geothermal potential, in particular sites at Tsenkher, Khujirt, and Shargaljuut, located in the Khangai region, may be used to produce energy. However, the most obvious and promising geothermal heat sources are not located in the close proximity of population centers; otherwise, these potential resources would be attractive for combined heat and power operations. Geothermal has very high upfront developments costs compared to other renewable energy prospects. In this context, none of the identified geothermal power schemes have advanced to development.

e) Ground Heat Pumps with Solar / Wind

40. Heat pump technology, as opposed the direct use of geothermal heat, allows utilization of underground heat resources nearer to the earth's surface. There are four types of heat pumps: air-air heat pumps, exhaust-air heat pumps, water-source heat pumps, and ground-source heat pumps (also referred to as geothermal heat pumps). Air-to-air heat pumps are commonly used as combined air conditioning and heating equipment in residential and commercial buildings. However, larger buildings, such as schools and hospitals, would be suited for ground-source heat pumps. The unit costs of a heat pump system well exceed the costs of a coal-fired heating boiler or electric heaters, but with widespread deployment both the system equipment and installation costs could be reduced. A heat pump has been demonstrated at a kindergarden at Dzuun Mod in Tuv aimag, with the support of the National Renewable Energy Centre. The system is combined with solar collectors and has proven successful and technically feasible.[7]

[6] Geothermal Energy Resources, Present Utilization and Future Developments in Mongolia 2005

[7] Replication and scale up of these hybrid systems is fully consistent with SREP objectives for access to energy and productive end uses. Pending further development of investment concepts, SREP cofinancing will support replication and scale up of systems combining ground source heat pumps and solar collectors.

I. Costs of Renewable Energy

41. The Renewable Energy Law of Mongolia was adopted by the State Great Hural in January 2007 and its Article 11 on Renewable Energy Tariffs and Prices sets the guidelines for the Feed-in-Tariffs (FiT) applicable to RE generators. According to the law, the Energy Regulatory Authority sets the tariffs and prices of energy generated and supplied by renewable energy power sources which are connected to transmission network. Tariffs are guaranteed to investors for a limited period of ten years from the date of the law, i.e. until January 2016. The law sets the following framework:

- Price of electricity supplied by a wind power source is US$ 0.08–0.095 per kWh
- Price of electricity supplied by hydropower station with capacity up to 5 MW is US$ 0.045–0.06 per kWh
- Price of electricity supplied by a solar power source is US$ 0.15–0.18 per kWh

42. According to the law, any price difference of electricity generated by a renewable energy power source, connected to a transmission network, shall be absorbed in selling prices of other generators connected to the transmission network.

43. The regulatory boards of aimags and the capital city can set tariffs of energy generated by stand-alone power sources within the following limits:

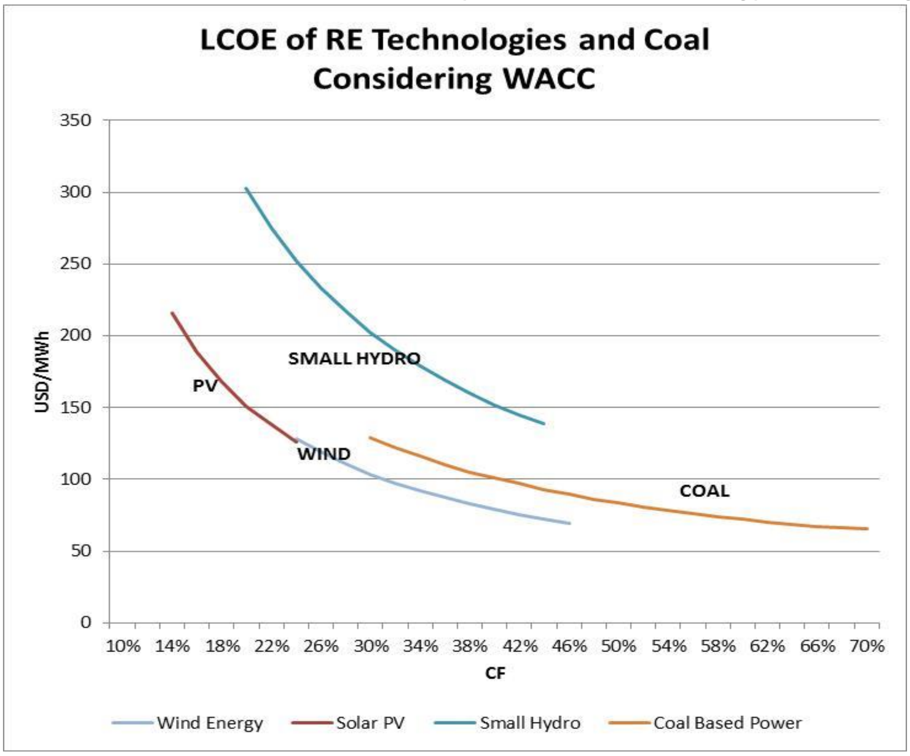
- US$ 0.10–0.15 per kWh of electricity by a wind power source;
- US$ 0.08–0.10 per kWh of electricity by a hydropower plant with a capacity of less than 500 kW;
- US$ 0.05–0.06 per kWh of electricity by a hydropower plant with a capacity of 501–2,000 kW;
- US$ 0.045–0.05 per kWh of electricity by a hydropower plant with a capacity of 2,001–5,000 kW;
- US$ 0.2–0.3 per kWh of electricity by a solar power source.

44. An analysis of these FiTs versus levelized costs of electricity (LCOE) for various resources and technologies indicates that the incentive levels are moderate but the number and scale of RE projects under development seems to confirm the adequacy of the current level of FiTs. Given the early stage of utility-scale RE development in Mongolia, the overall incentive level, and the rapidly evolving installed system costs, the incentives should be reviewed from time to time in light of the national RE targets going forward. Experience in other countries shows that FiTs and other incentives can be adjusted as learning rates[8] become evident within the country.[9] A summary of the LCOEs of RE technologies, and a comparison to the existing FiTs in Mongolia, is presented below in chart form. The assumptions used for the LCoE analyses are provided as Annex E.

[8] The learning rate is the RE system cost reduction associated with a doubling of installed capacity. Globally during the past several years, learning rates have been faster for solar PV and wind than for other RE systems.

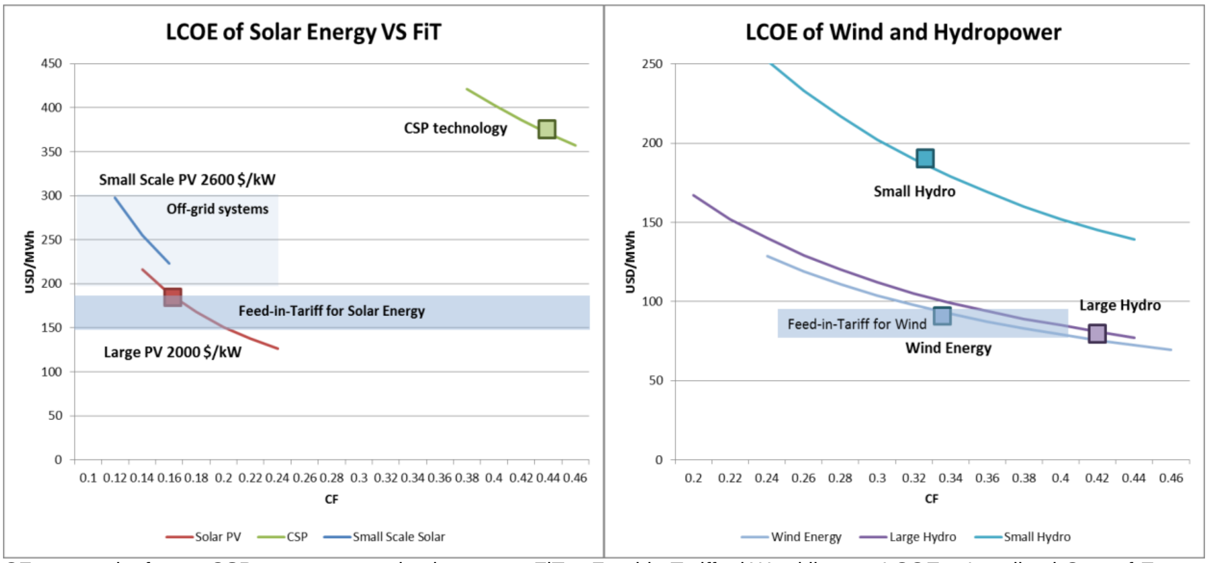
[9] For example, India's solar program mainly utilizes benchmark tariffs and competitive bidding (including reverse auctions), with FiTs used in some states. Since 2011, more than 3 GW of utility-scale solar has been added to the grid; in every round of bidding every project offer has been below the benchmark tariffs established by India's Central Electricity Regulatory Commission. The most recent round included bids at US$0.09/kWh and lower.

Figure 9: Levelized Costs of Electricity of Renewable Energy Technologies



LCOE = Levelized Cost of Energy, MWh = megawatt-hour, RE = renewable energy, PV = photovoltaic, WACC = Weighted Average Cost of Capital.

Figure 10: Mongolian Feed-in Tariffs for Solar, Wind and Hydropower



CF = capacity factor, CSP = concentrated solar power, FiT = Feed-in Tariffs, kW = kilowatt, LCOE = Levelized Cost of Energy, MWh = megawatt-hour, PV = photovoltaic.

J. Barriers to Commercial Renewable Energy

45. The initial operation of the FiT system proved to be inadequately financed with respect to monthly cash flow payments to renewable energy generators (payments were made at the end of the year). The National Transmission Company (NTC) was responsible for managing a Zero-Balance Account, from which the generators were compensated for their supplied energy. FiT payments were reimbursed to the NTC in the form of a direct subsidy from the government. This

caused negative impacts on the financial statements of NTC, which in turn influenced their ability to borrow money and fund essential investments in other electricity network business operations. The RE law was amended in 2015 and the responsibility of managing the Zero-Balance Account was transferred to the National Dispatching Centre.

46. The RE law amendment also saw the introduction of an RE green surcharge. This surcharge recognizes that the existing tariff structure is based on accounting rather than economic principles. The existing CHP plants have been fully amortized and depreciated, and coal is abundant and subsidized. In strict financial terms, the existing CHPs are very low cost energy systems compared to new RE systems. Tariff revenues reflect these conditions and do not support FiT payments. The green surcharge is intended to recover revenues sufficient to pay for new RE systems; in this regard the surcharge is a forward looking tariff component.

47. The RE law amendment was designed to improve the financial management of the power sector. However, there remain some ambiguities that may affect the confidence of the private sector when considering investment in RE. Such ambiguities relate to transparency and intent of the regulations governing RE.

48. **Transparency.** The law stipulates, on one hand, that the system is obligated to receive the energy supplied by RE generators, but on the other hand, the system dispatcher has the right to dispatch and consequently may refuse such energy. The matter of obligating to compensate for curtailed energy could be managed by a transparent, universal regulation, but instead is managed by stipulations of the Power Purchase Agreements (PPAs). This leads to the potential for unfair and inequitable treatment of RE generators (or at least a perception on the part of investors).

49. **Curtailment of RE.** RE generation capacity has the lowest marginal cost and should therefore always be dispatched before thermal plant. CHP4 is, de facto, acting as the load following generator in the system. However, it has had no formally/contractually designated responsibility to do so, and no financial incentives to carry out this function. In July 2015, ERC introduced a Two-Part Tariff (comprised of capacity and energy charge) which gives financial incentives to CHP 4 to act as load following plant at least until the planned Egiin Hydropower plant starts operation after 2021. Nevertheless, this change in regulation does not ensure that some operational actions, which could be carried out to accommodate intermittent RE energy, are carried out. Whilst there are technical constraints that limit the flexibility of the old Russian-designed CHP plants, engineering analysis suggests that more could be done by thermal plant operators so that RE generators might be curtailed less frequently than has been observed. Furthermore, as mentioned above, the existing CHP plants are fully depreciated and coal is subsidized, meaning that the existing plants are low cost in strict financial terms. The subsidies lead to a perception on the part of privately-owned RE generators that in times of financial austerity, there is the potential for CHP’s to be favored in the merit order of dispatch as a budgetary measure. Such concerns could be addressed if the National Dispatching Centre was to provide registered parties with a daily operations log summary that included reasons for curtailment if any.

50. **Statement of Opportunity.** There is a licensing principle ambiguity that arises because there are no criteria for rejecting RE applications for licenses in the event that the target levels for RE in a given area are exceeded, but in practice not all licensed projects can proceed. It has been observed that several RE plants have been granted licenses but not all of the projects have proceeded to implementation due to considerations related to grid operation. This can mean that an RE developer makes an investment to secure a license but may not recover his investment. This issue could be addressed by publishing an annual statement of opportunity where the needed and maximum absorption capacity of intermittent RE would be specified by energy system.

51. **Financing.** As an external barrier, amplified by the above uncertainties and consequent risk perception, the lending market is volatile and loan interest rates are high for RE projects impacting RE business development particularly by small and medium scale companies depending on local financing.

52. **O&M Support.** The performance of past RE projects of small and medium size in sparsely populated areas of Mongolia is relatively poor. Many systems have been abandoned due to lack of proper operation and maintenance. This experience suggests that RE systems should be applied at larger population centres where MW scale systems (vs. kW scale) can be deployed and connected to the grid. Wherever possible, RE generation facilities could be developed to the vicinity of substations or other power generation facilities and be maintained by the local electric utility.

53. **Ability to Pay.** The poverty headcount ratio of Mongolia is 27%. In Khuvsgul aimag, which is the second poorest in Mongolia, the Gross Domestic Product (GDP) per capita is about 50%, and the mean annual salary about 80% of the national average. Ability to pay therefore is a significant barrier to stand-alone RE systems in remote areas. With all soum centres now grid connected, this hurdle remains in the outskirts of the population centers and among herders with no permanent electrified dwelling in towns.

54. The above barriers are discussed in detail in Annex A.

III. CONTRIBUTION TO THE NATIONAL ENERGY ROADMAP

55. The proposed SREP investments will support the government's target of increasing the share of renewable energy (RE) in the country's energy mix. The following key policies, listed in chronological order from past to present, define the target levels for increasing RE in Mongolia's energy system:

- The National Renewable Energy Programme (2005 – 2020) approved by the State Great Khural (Parliament of Mongolia) with its eleven paragraphs has a goal to increase the penetration of renewable energy in the energy system of Mongolia, improve the structure of power supply, and utilize renewable energy in off-grid soums (districts) and settlements to ensure ecological balance and improve the economic efficiency. The programme lists both broad policy actions and individual investment projects for implementation. The programme aims at gradually increasing the share of renewable energy in total energy production to reach 3-5 percent by 2010 and 20-25 percent by 2020.
- The implementation plan for the first phase of National Action Program on Climate Change (NAPCC) 2011-2021, was approved in 2011. In the first phase (2011-2016), among the many actions NAPCC states under Strategic Objective 3 "Mitigate GHG emissions and establish low carbon economy through the introduction of environmentally friendly technologies and improvement in energy effectiveness and efficiency" and in particular to "Develop wind and solar energy production systems" (Action 3.3.4).
- As the latest, the State Policy of Energy (2015 – 2030) was approved and adopted by the Parliament 19 June 2015.

56. The State Policy of Energy states that under the scope of decreasing negative environmental impacts, reduction of greenhouse gas emissions and increasing RE (Clause 3.2.6) the country will:

- Develop institutional capacity to perform detailed resource assessment of Mongolian renewable energy resources (solar, wind, hydro, geothermal, biomass and etc.), build national renewable energy resource database and perform research and development in field of renewable energy.
- Increase share of renewable energy in national energy capacity to 20% by 2023, 30% by 2030.
- Build favorable legal, tax environment to increase investment in renewable energy, create financial mechanism to support energy production by renewable energy.
- Support use of solar energy, wind energy, biomass, liquid pressed gas, fuel geothermal energy, fuel cell and other new energy sources for energy supply of remote users in "bag" centers and isolated settlements.
- Decrease negative environmental effect for energy production, transmission and distribution.
- Improve environmental impact monitoring.

K. Meeting National Renewable Energy Capacity Targets

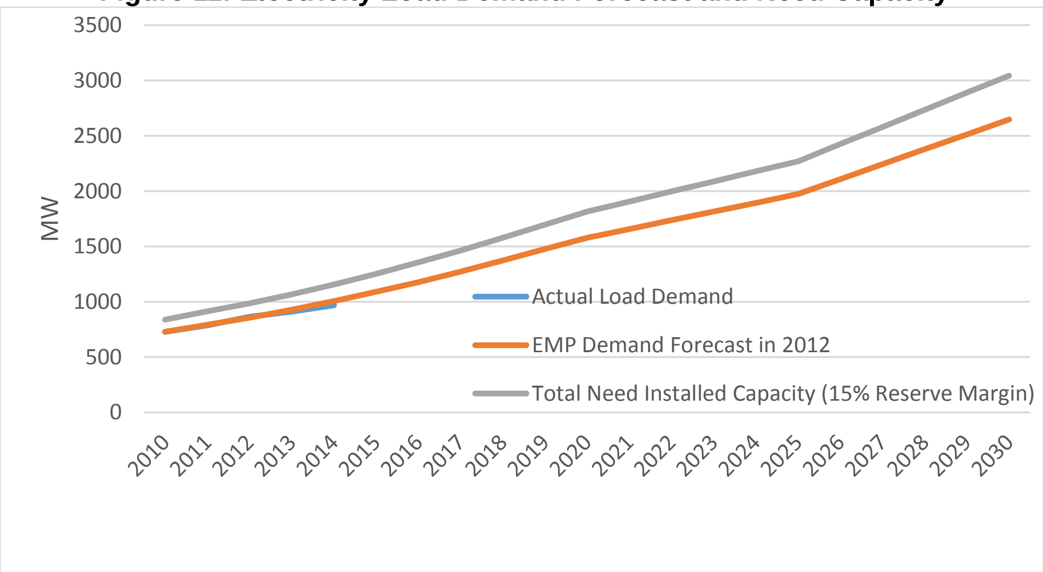
57. Renewable energy currently contributes around 7.6% of the total installed capacity in the country (on capacity basis). The achievement of the State Energy Policy targets must take into account the existing and anticipated development of RE and thermal plants. The following developments are considered sufficiently likely to be built by 2023 to be included in the computation of RE needed capacity:

1) Ulaanbaatar CHP5 415MW_e thermal plant - a concession agreement was signed in June 2014 and a PPA in August 2015. Completion of construction is planned by 2020;
2) Baganuur 700 MW coal-fired plant (130 km east of Ulaanbaatar) - the government signed a concession agreement in April 2015 and a PPA in August 2015. The plant is expected to be completed in 2019;

3) Tavan Tolgoi 450 MW coal-fired power plant - it is planned to construct this plant in the South Gobi to supply the Tavan Tolgoi coking coal mine and the Oyu Tolgoi gold and copper mine;
4) Telmen (Khovd province) 90 MW coal-fired plant - this power plant will supply mining developments. Construction is expected before 2023;
5) Egiin Gol HPP - the government requested funds from China in March 2015 for the purpose of building a 315 MW hydropower plant on the Egiin river. The plant is expected to be completed in 2022/23; and
6) Sainshand wind farm (52 MW) – the developers hold a signed PPA. The windfarm is expected to commence operation in 2016.
7) Tsetsii wind farm (50 MW) is reported to be more advanced than the Sainshand windfarm.
8) Choir wind farm (50 MW).

58. Mongolia energy sector is supply deficit due to the past limited investment in capacity addition, and relies upon electricity import from Russia to cover supply shortage. Although demand and supply gap is narrowing mainly due to recent CHP4 capacity expansion, current total installed capacity (969 MW) has failed to meet actual load demand (1,006 MW) in 2014. Long term electricity load demand forecasting was carried out in 2012 as a part of updating energy sector master plan, which estimated around 9% of annual demand growth as base case. In spite of recent economic slow-down, actual electricity load demand growth has been on the long term forecasting trajectory. Given that the demand grows in line with such trajectory, load demand growth will be increasing to 2,617 MW in 2030, and the need install capacity to meet demand (including 15% of safety reserve margin) will be more than 3,000 MW. (Figure 11)

Figure 11: Electricity Load Demand Forecast and Need Capacity



59. Table 5 provides an estimate of the RE capacity required to meet the national RE targets. It has been assumed that all new thermal capacity will be built by 2023. It is noted that there is a history of thermal plant development which may result in a reduced RE target; alternatively it may be necessary to accelerate RE to meet demand.

Table 5: Required RE Capacity to meet National RE Targets

Existing Thermal	MW	New Thermal	MW	Total Thermal (MW)
CHP2	24			24
CHP3	148			148

Existing Thermal	MW	New Thermal	MW	Total Thermal (MW)
CHP4	580			580
Darkhan CHP	48			48
Erdenet CHP	36			36
Choibalsan CHP	36			36
Dalanzadgad CHP	6			6
		CHP5	415	415
		Baganuur	700	700
		OT/TT	450	450
		Telmen	90	90
Total Thermal	**878**		**1,655**	**2,533**
Existing RE	**MW**	**New RE**	**MW**	**Total RE MW**
Salkhit Windfarm	50			50
Solar Home Systems	10			10
Durgun HPP	12			12
Taishir HPP	4			4
Small HPPs	15			15
		Egiin	315	315
		Sainshand Windfarm	52	52
		Tsetsii Windfarm	50	50
		Choir Windfarm	50	50
Total RE	**91**		**467**	**558**
	Committed % of RE on Total Capacity by 2023			**18%**
		Additional RE required to meet 20% in 2023	75	633
		Additional RE required to meet 30% by 2030 (assuming no additional thermal)	527	1,085

CHP = combined heat and power, HPP = hydropower plant, MW = megawatt, OT/TT = Oyu Tolgoi/Tavan Tolgoi, RE = renewable energy.
Source: Ministry of Energy

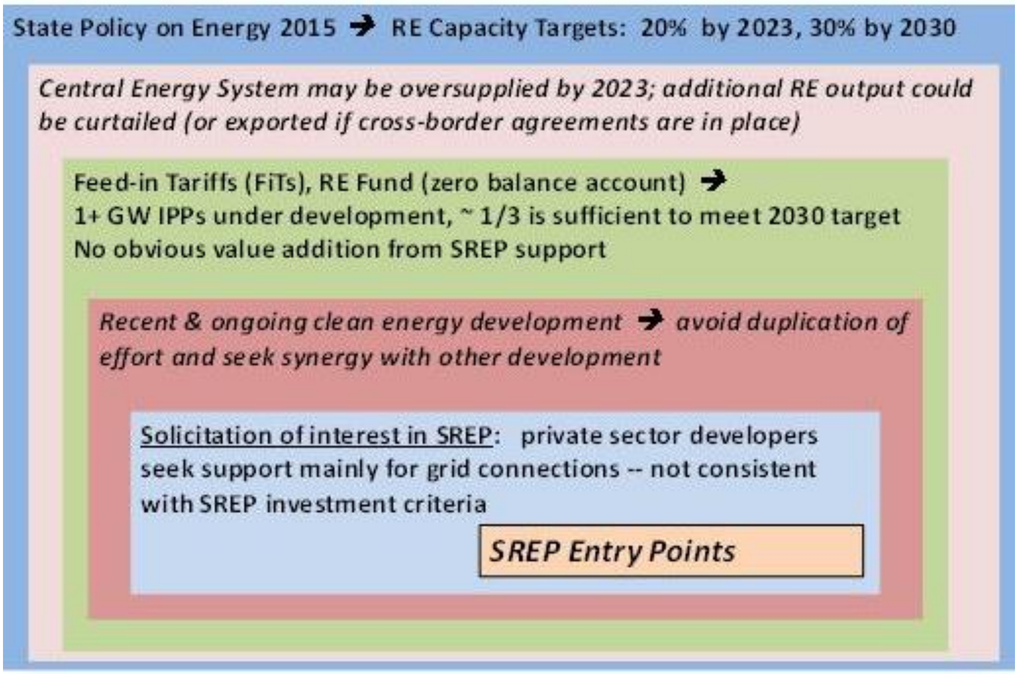
60. The additional RE capacity required by 2023 is around 75 MW. An additional 450 MW will be required by 2030 for a total of 530 MW to reach to 30% of total capacity.

61. Reducing electricity import to achieve energy security is long term goal of GoM because of growing reliance upon electricity supply from Siberian Grid in Russia which has been attributed by limited investment on power capacity addition for decades, and accordingly energy planning emphasizes development of indigenous energy reserves, and expansion of RE supplies as key avenues to improve electricity and heating services while at the same time promoting energy security through diversity of supply.

IV. SREP PROGRAM DESCRIPTION

62. The discussion in the previous sections indicates that although there are barriers to RE development, (i) the existing policy regime is about to be successful in terms of mobilizing private sector investment in utility-scale grid-connected RE projects, (ii) there is limited or no value addition for SREP in the current private sector development queue, and (iii) there is limited potential value addition for concessional finance in the CES at present. Considering the current RE development status, and the overall SREP objectives for promoting RE capacity and output, access to energy, and productive end use of energy, GoM believes that limited SREP resources should be directed toward projects in non-CES systems in poor regions which are heavily dependent on electricity imports from neighboring countries, and are not attractive to private sector developers and investors, though may be less commercial in the near term but which have large replication and scale-up potential.[10] At the same time, issues associated with the regulatory environment and central government policy are barriers for large private sector projects in CES. The screening process to identify SREP entry points is illustrated in Figure 12.

Figure 12: Renewable Energy Policy Context and Possible SREP Entry Points

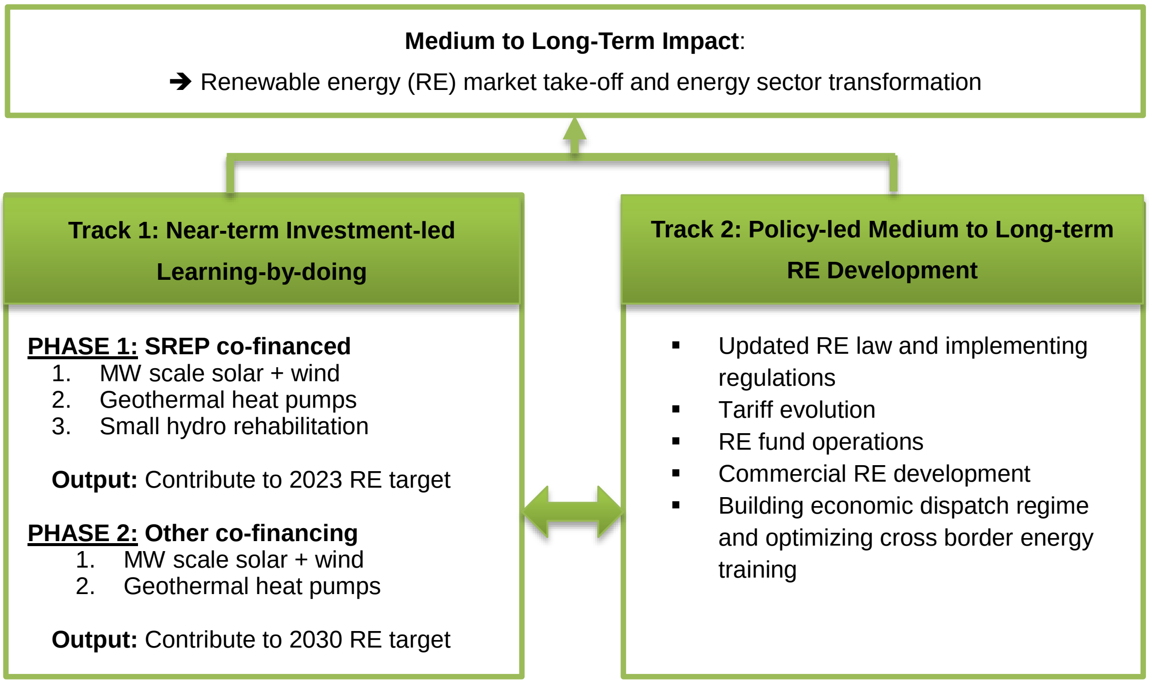


63. Based on the overall RE program experience to date, GoM believes that scarce SREP resources should be directed to a phased 2-track approach (see Figure 13), with most funds utilized in upscaling rural renewable energy through learning-by-doing in non-CES grid systems (Track 1) with two phases while complemented by technical assistance for strengthening renewable energy regulations to create enabling environment for private led renewable energy development (Track 2); the medium-long-term result will be an improved and expanded foundation for aggressive replication and scale up of RE development. [11]

[10] In fact, some private developers have implemented feasibility study in small hydro and solar PV in the western region. Major perceived risks are economics of RE plants due to relatively higher anticipated CAPEX (because of long transportation distance) and lower RE resource endowment compared to projects in CES (which has attracted most of the private sector interest). Successful demonstration of RE projects in Phase 1 is expected to give comfort on RE plant performance and CAPEX in the western region so that potential private sector could anticipate more precise project cash flow. Low cost financing through financial intermediation planned in phase 2 is expected to provide buy-down effects to put private sector plants'' LCOE within the current FiT range.

[11] Three private sector wind firms (3 x 50 MW) will start construction in 2016 (see Annex B). Recent tariff reforms implemented since July 2015 have given these developers assurance on long term FiT payment. Further evolution of the regulatory

Figure 13: Renewable Energy Investment Framework



64. Phase 1 activities will utilize SREP cofinancing to:

a) Demonstrate MW-scale renewable energy installations in Western Region Energy System including electricity supplies from solar, wind, and small hydro, and heat services using geothermal heat pumps; and
b) Support the RE policy and regulatory framework to encourage accelerated private led investment in utility-scale grid-connected projects (including private sector projects) and facilitate policy evolution to mobilize investment in RE projects in CES.

65. These activities will build public confidence in renewable energy technologies to create market demand. Activities in Phase 2 and beyond could include, but not be limited to:

c) Investment in replication and scale-up of successful Phase 1 activities in Western Region Energy System, Altai Uliastai Energy System, and Eastern Region Energy System ; and
d) Support for private sector RE projects in non-CES, whichever feasible, possibly through financial intermediation arrangements.

66. The following sections describe a set of investment and advisory concepts, the transformational impact of each, the activities envisioned for each, and expected benefits.

L. Phase 1 - Track 1: Upscaling Rural Renewable Energy

1. Background

67. The rural areas of Mongolia are characterized by long distances between small population centers. These characteristics are ideal for the deployment of distributed RE. The typical benefits associated with the deployment of RE in rural areas are as follows:

- Reduction in electricity imports and higher level of energy independence
- Marginal future CAPEX savings in long, lightly-loaded transmission networks
- Reduction in transmission losses and associated CO_2 benefits

framework is necessary as noted (see Table 7).

- Job creation and skills development in building sustainable energy systems
- Demonstrating utility-based as opposed to community-based O&M solutions for medium sized RE technologies in remote areas of Mongolia
- Demonstrating that small HPPs can be successfully rehabilitated and subsequently operated and maintained on a sustainable basis
- Demonstrating shallow ground heat pump technology

2. Expected Outcomes

68. The objective of Track 1 is to demonstrate the viability of RE in a rural area of the country.

3. Expected Outputs

69. The expected outputs are as follows:

- The establishment of RE sources of 25 MW (20 MW solar PV, 5 MW wind) in the Western Energy System. The load growth of WES indicates that growth will continue around 9% annually. With this estimate the SREP project could contribute to obtaining around 19% of electricity to the region from the new RE plants.
- The refurbishment of Uench micro-hydro HPP will demonstrate that existing hydropower resources can be recovered and maintained to the benefit of local communities.
- The installation of shallow grand heat pump technology in five locations to demonstrate its performance as alternative clean heat source in local communities.
- The enhanced financial and managerial capacity of WRES SOJSC.
- SREP funding will support the creation of jobs related to the construction/installation, operation and maintenance of renewable technologies. Education of the workforce in the deployment of these technologies will be a feature of the Western Energy System RE project.

70. More details are provided under Annex G - Project Concept Notes.

4. Costs and Financing

71. The total estimated cost of the Upscaling Rural Renewable Energy in Phase 1-Track 1 is as follows:

Table 6: Upscaling Rural RE Costs and Sources of Financing
(US$ million)

	Private Sector	SREP			MDB[a]		GoM / WRES	TOTAL
		Total	ADB	WB	ADB	WB		
Investment Plan Components								
PHASE 1 - TRACK 1: Upscaling Rural Renewable Energy								
1. Solar PV power plants 2x10 MW	-	24.8	12.4	12.4	11.4	11.4	1.0	48.6
2. Wind energy plant 1 X 5 MW	-	-	-	-	11.5	-	0.5	12.0
3. Small hydropower development X 1	-	1.2	1.2	-	-	-	0.1	1.3
4. Shallow Ground Heat Pumps x 5	-	1.0	1.0	-	-	-	0.1	1.1
5. Technical assistance	-	1.5	1.0	0.5	-	-	0.2	1.7
Subtotal	**-**	**28.5**	**15.6**	**12.9**	**22.9**	**11.4**	**1.9**	**64.7**

ADB = Asian Development Bank, GoM = Government of Mongolia, MDB = multilateral development bank, MW = megawatt, PV = photovoltaic, SREP = Scaling-up Renewable Energy for low-income countries Programme, WB = World Bank, WRES = Western Region Energy System.
Note:

[a] Financing by MDBs may be provided as either loan or grant (or both) depending on Mongolian government decision for utilizing country allocation of respective agencies

72. The solar PV, wind energy and mini-hydro projects are assumed to be financially feasible under Mongolia's FiT tariffs. The local state-owned electric utility company WRES SOJSC is currently in poor financial standing and operating at a loss. As sales are forecast to grow and the marginal cost of sales is higher than the revenues, the losses will accumulate to very high levels resulting in an ever-increasing fiscal burden to the central government. Therefore, there is a pressing need to increase tariffs whilst simultaneously seeking better operational efficiency and reduced costs.[12]

73. The SREP support to the planned investments together with the law-based FiT payments from the government support fund for RE generators, would, de facto, improve the financial status of WRES SOJSC. If FiT payments are paid to a state-owned RE generator entity from the government fund as it is paid to private RE companies, part of the direct subsidies now paid annually to WRES SOJSC would be replaced by law-based revenues, thus improving the company's financial standing. In addition, power purchase bills from Russia and China will be reduced. Finally, higher operational efficiency through reduced transmission losses would bring about additional benefits to WRES SOJSC.

M. Phase 1 - Track 2: Strengthening Renewable Energy Regulations

1. Background

74. The barrier analysis of Section III elaborated a set of key barriers to development of RE in Mongolia. Table 7 summarizes the key barriers and suggests capacity building activities designed to overcome them.

Table 7: Key Barriers to RE Development and Proposed Capacity Building

Key Barrier	Problem	Beneficiary / Scope of Capacity Building / MDB
Existing market regulation and structure	Fundamental issues with regulatory reform and planning processes that leave investments in energy infrastructure projects and market development prone to failure	**Beneficiary**: ERC **Scope:** The capacity building program will include the following key topical areas -- "System Operations" is focused on: (i) RE integration coupled with development of both the policy-making capacity and market development; (ii) co-optimization of the heat and electricity systems; and (iii) distributed generation. "Regulatory Core Functions" is focused on: (i) better integration and optimization of the electricity tariffs; (ii) embedding EE into the utilities operating roles; (iii) market entry and regulatory structure of the electricity market; and (iv) impacts of the electricity system on air pollution and human health. "Energy Modelling, System Planning and Policy Making" is

[12] WES SOJSC covers an isolated region where utility management has clearly been resourceful in providing a stable power supply. There is a complex load shedding system in place that operates successfully on occasions when supply from Russia is lost. The Durgun HPP must operate in an island mode, regulating the power supply, and load is shed where possible while maintaining supply to uninterruptible customers such as hospitals. The very cold winters and harsh climate pose another challenge in maintaining the electricity network but the performance statistics indicate that the company does well. The poor financial status of the company is a reflection of a social policy that restricts revenue by keeping tariffs affordable, it is not a reflection of the financial capacity of management. Recent tariff reform (tariff increase, introduction of tariff indexation, and of two part tariff, together with RE surcharge) which is also applicable to WRES is significant step toward financial sustainability.

Key Barrier	Problem	Beneficiary / Scope of Capacity Building / MDB
		focused on building data-based capacity with looking at short, medium and long-term issues such as, energy security, infrastructure capacity expansion, market dispatch and clearing, and power system flows. **MDB:** IBRD
Inadequate financing of the FiT	Negative financial impact on the national transmission company Growing concern over long-term FiT payments due to a lack of renewable energy surcharge system.	**Beneficiary:** ERC / MoE The FiT system has been addressed by recent change of RE law and changes to the administration of the zero balance account; the main change has been the introduction of a "green surcharge" system in July 2015. Going forward, it is essential to build clear and transparent rules to increase level of RE surcharge according to RE capacity addition. Some consideration needs to be given to alternative financing arrangements, especially if national RE targets are increased above 30% after 2030. **MDB:** IBRD
RE curtailment	Dispatcher's right to curtail versus obligation to accept RE generators energy production	**Beneficiary:** NDC (primary) and ERC (secondary) **Scope:** Clarify the dispatching principles in the Mongolian Grid Code. Provide training on wide basis in marginal cost dispatch principles, demonstrating the false economy that existing depreciated power generators are more economical than RE generators. Optimize the dispatch of imported electricity in the network from Russia and thermal power generators. **MDB:** IBRD
Licensing Principle Ambiguity	A lack of criteria for rejecting RE applications for licenses in cases the target levels for RE are exceeded or where technical constraints in the transmission grid do not allow construction of further RE capacity.	**Beneficiary:** MoE **Scope:** Develop suitable criteria for inclusion in the regulatory (and possible legal) framework. Design a 'statement of opportunities' process to deliver suitable time-bound incremental targets for RE, to improve transparency to all RE stakeholders. Develop a study on economic and physical grid absorption capacity for RE in Mongolia. **MDB:** IBRD

EE = energy efficiency, ERC = Energy Regulatory Commission, FiT = Feed-in Tariff, IBRD = International Bank for Reconstruction and Development, MDB = multilateral development bank, MoE = Ministry of Energy, NDC = National Dispatching Center, RE = Renewable Energy.

2. Expected Outcomes

75. The objectives of the Strengthening RE Regulations project are to rationalize the basis on which RE schemes are motivated and to encourage private sector investment in RE.

3. Expected Outputs

76. The improvement of the regulatory framework will support the achievement of the national targets by ensuring private sector participation in the development of RE in the CES. The long-term target of 30% RE by 2030 will require around 530 MW of RE in the CES, a capacity that is likely to be provided by the private sector in the form of wind and solar PV if the regulatory framework provides adequate confidence for investors. The impact of SREP funding will be to introduce transformational change through improved market and financial conditions and encouragement of private sector participation. The output of the Strengthening RE Regulation project can be measured as timely development of RE projects by the private sector.

4. Costs and Financing

77. The total estimated cost of the Strengthening RE Regulations project is as follows:

Table 8: RE Capacity Building Project Costs and Sources of Financing

(US$ million)

	Private Sector	SREP			MDB		GoM	TOTAL
		Total	ADB	WB	ADB	WB		
Investment Plan Components								
PHASE 1 - TRACK 2: Strengthening Renewable Energy Regulations								
6. Technical assistance for ERC and NDC	-	1.2	-	1.2	-	-	0.1	1.3
Subtotal	**-**	**1.2**	**-**	**1.2**	**-**	**-**	**0.1**	**1.3**

ADB = Asian Development Bank, ERC = Energy Regulatory Commission, GoM = Government of Mongolia, MDB = multilateral development bank, NDC=National Dispatching Center, RE = renewable energy, SREP = Scaling-up Renewable Energy for low-income countries Programme, WB = World Bank, WRES = Western Region Energy System.

V. FINANCING PLAN AND INSTRUMENTS

78. Table 9 presents a plan for financing the projects described in Section VI. It shows the proposed fund allocation from SREP as well as estimates of the amounts anticipated from multilateral development banks (MDBs), government and the private sector.

79. As the table shows, US$ 29.7 million of SREP funding is expected to catalyze 1.2 times as much investment, most from sovereign loan with a small contribution from the Government. When Phase 2 investments (scaling-up and replication) are included the leverage is 4.1.

Table 9: Summary of Financing Plan for Mongolia
(US$ million)

		Private Sector	SREP			MDB[a]		GoM / WRES	TOTAL
			Total	ADB	World Bank	ADB	World Bank		
Investment Plan Components									
PHASE 1 - TRACK 1: Upscaling Rural Renewable Energy									
1.	Solar PV power plants 2x10 MW	-	24.8	12.4	12.4	11.4	11.4	1.0	48.6
2.	Wind energy plant 1 X 5 MW	-	-	-	-	11.5	-	0.5	12.0
3.	Small hydropower development X 1	-	1.2	1.2	-	-	-	0.1	1.3
4.	Shallow Ground Heat Pumps x 5	-	1.0	1.0	-	-	-	0.1	1.1
5.	Technical assistance	-	1.5	1.0	0.5	-	-	0.2	1.7
	Subtotal	**-**	**28.5**	**15.6**	**12.9**	**22.9**	**11.4**	**1.9**	**64.7**
PHASE 1 - TRACK 2: Strengthening Renewable Energy Regulations									
6.	Technical assistance for ERC and NDC	-	1.2	-	1.2	-	-	0.1	1.3
	Subtotal	**-**	**1.2**	**-**	**1.2**	**-**	**-**	**0.1**	**1.3**
	PHASE 1 TOTAL		**29.7**	**15.6**	**14.1**	**22.9**	**11.4**	**2.0**	**66.0**
PHASE 2									
7.	Scale up / replication in WES and AuES (20 MW)	tbd	-	-	-	35.0	-	3.5	38.5
8.	Scale up / replication in EES (30 MW)	tbd	-	-	-	42.1	-	4.2	46.3
	PHASE 1 and 2 TOTAL	**tbd**	**29.7**[b]	**15.6**	**14.1**	**100.0**	**11.4**	**9.7**	**150.8**

ADB = Asian Development Bank, AuES = Altai Uliastai Energy System, EES = Eastern Energy System, ERC = Energy Regulatory Commission, GoM = Government of Mongolia, MW = megawatt, NDC=National Dispatching Center, PV = photovoltaic, SREP = Scaling-up Renewable Energy for low-income countries Programme, tbd = to be determined, WB = World Bank, WES = Western Energy System, WRES = WRES State-Owned Joint Stock Company.

Notes:
[a] Financing by MDBs may be provided as either loan or grant (or both) depending on Mongolian government decision for utilizing country allocation of respective agencies.
[b] Excludes IP preparation grant of US$ 0.3 million.

Source: Ministry of Energy estimates.

VI. RESPONSIVENESS TO SREP CRITERIA

80. The Investment Plan's responsiveness to SREP criteria is summarized in the table below.

Table 10: Summary of Projects' Responsiveness to SREP Criteria

SREP Criteria	Track 1: Upscaling rural renewable energy	Track 2: Strengthening renewable energy regulations
Increased installed capacity from renewable energy sources	Mongolia intends to increase share of RE to 30% by 2030. Investment in RE in the WES is an important step to facilitate and demonstrate the potential to scale up outside CES in the regional grids by the public sector.	The TA will help to remove barriers, particularly in the CES area where a number of private sector initiatives are waiting to proceed but are impacted negatively by perceived regulatory risks
Increased access to energy through renewable energy sources	The installation of 25 MW RE capacity in the Western Energy System will benefit around 20,000 households with access to clean energy. This will complement the previously undertaken pilot projects of electrifying remote soum centers using wind-diesel, solar-diesel and diesel-only systems, but with poor operational result. This led to the country to grid-electrify all soums. This campaign has been completed successfully, and the country has secured electricity to urban population. As to herders, there has been 100 000 solar PV systems campaign which provided movable systems to rural herder population.	
Low Emission Development	Planned solar PV, wind, heat pump, and small hydro facilities are nearly zero emission plants	The assistance potentially triggers RE development in hundreds of megawatts with huge reducing impact on CO_2 emissions from coal based power generation.
Affordability and competitiveness of renewable resources	On commercial basis, the project will bring about benefits in terms of (i) reduced imports from Russia and (ii) reduced electricity transmission losses. However, as the local retail electricity tariffs are highly subsidized and not cost-recovering, and therefore the project cannot alleviate affordability issue. It still provides a nearly least-cost solution to regional power generation and helps to set non-CES systems on healthier financing standing.	The utility scale solar PV and wind energy are not yet cost competitive with existing thermal generation options even though wind energy is nearly competitive if coal externalities are counted and currently prevailing subsidies are removed from thermal power. SREP financing will help kick-start the industry, and thus help Mongolia further in the (local) learning curve.

SREP Criteria	Track 1: Upscaling rural renewable energy	Track 2: Strengthening renewable energy regulations
Productive use of energy	Solar PV generates electricity during high- demand daytime periods and will similarly enhance supply adequacy and reliability during the hours of the day in which the value of lost load and losses are typically the highest. Wind energy will supplement the supply. The small hydropower plant will replace part of imports from China to three southern soums.	There is good untapped potential in the many private sector RE projects which could contribute to the supply to CES but are currently on hold or move slow. The grid absorption capacity would allow many of them proceed without major curtailment issues.
Economic, social and environmental development impact	Wind, solar and micro-hydro projects, both in CES and non-CES, are of minimal negative environmental impact whereas their contribution to reduction of greenhouse gases and urban pollution in major cities is significant. The project will provide training and capacity building, demonstration of technologies and employment opportunity extending to the remote Western Region of the country, which is lagging behind in economic development and income as compared to the country's average.	
Economic and financial viability	As to providing electricity for the expanded demand, coal is not an option for WES as the overall demand in terms of megawatts is low. The potential to be interconnected to CES system, hence avoid generation investments, is far ahead in the future. Large scale hydropower plants of the region have not been found feasible. The development of import tariff is uncertain, and the government wishes to increase energy independence. Therefore, solar PV, wind and small hydro position well in least cost order even though medium sized hydro may stand highest. With RE Law based Feed-in-Tariff, the RE plants are also financially feasible.	The investments hoped to be accelerated by the TA are all carried out by private sector. Most of the projects have already had their FS phases passed and FS reports approved by the government.

SREP Criteria	Track 1: Upscaling rural renewable energy	Track 2: Strengthening renewable energy regulations
Leveraging of additional resources	Non-CES is in poor financial standing and not able to fund even financially and economically attractive investments. The daily operations depend on central government subsidies. In the long term interest of the region and its people, most of financing must come from external sources. With the FiT system, part of provisional subsidies can be converted to law-based income transfers.	The institutional and regulatory framework is conducive to RE investment but there are details which hold back the investments. The small TA may potentially trigger the next projects in pipeline to implementation. They are all of private sector, and include around 100 MW wind capacity in two projects, and 50 MW of solar PV capacity, totally around $300 million in total investments.
Gender	Women will equally benefit from better security and reliability of supply. Each project also offers possible opportunities for targeted job creation for women (for example, requirements that the plant operators provide earmarked jobs for women. Mongolia has a generally good track record in allowing and promoting women's career development.	
Co-benefits of renewable energy scale-up	There are a number of co-benefits associated with the project. Most notably the project will help Mongolia to reduce air pollutant emission in cities and towns, and improve its image as a target of foreign and private sector investments.	

CES = Central Energy System, FiT = Feed-in Tariff, FS = feasibility studies, MW = megawatt, PV = photovoltaic, RE = renewable energy, SREP = Scaling-up Renewable Energy for low income countries Program, TA = technical assistance, WES = Western Energy System.

VII. IMPLEMENTATION POTENTIAL WITH RISK ASSESSMENT

81. Table 11 describes implementation potential in terms of risks and mitigations.

Table 11: Implementation Potential and Risk Summary

RISK	MITIGATION	RESIDUAL RISK
Project Readiness	The WES RE project pre-feasibility study sponsored by the ADB was completed in August 2015. Capacity building (technical assistance) does not involve more than a willingness on the part of government to set an implementation schedule.	Low
Policy and Regulatory Framework	The capacity building project targets improvement to the regulatory framework; assuming that the work is completed and improvements agreed, the residual risk relates to an inability on the part of government to act on the recommendations.	Medium
Implementation Capacity	TA assistance will be required for the WES RE project and capacity building and has been included in the scope of works and budget.	Low to Medium
Private Participation Private sector is sensitive to regulatory risks	The capacity building related to the regulatory framework is intended to promote the involvement of the private sector in RE development, including remote areas.	Medium
Scale-up and Replication	The RE project in the Western Energy System will demonstrate that the development of renewable energy in remote areas can be undertaken successfully and support replication and scaling up in other areas.	Medium
Safeguards	Projects will adhere to all GoM and multilateral development bank safeguard and environmental protection policies. Appropriate environmental management and social development mitigation measures will be incorporated into project design and due diligence. Appropriate and meaningful consultations will be held with stakeholders. Advisory services will be provided to upgrade and enhance domestic capacity to implement good practice safeguard measures in heat pump development (as well as commercial lender capacity to assess risks). Potential impacts from EE and RE are mostly confined to "inside-the-fence" operations.	Low

ADB = Asian Development Bank, EE = energy efficiency, GoM = Government of Mongolia, RE = renewable energy, TA = technical assistance, WES = Western Energy System.

Source: Ministry of Energy and SREP Technical Team

VIII. MONITORING AND EVALUATION

82. A monitoring and evaluation (M&E) framework will be established by the Government, in cooperation with the MDBs, for the purpose of tracking and reporting on progress in achieving SREP objectives and outcomes. The M&E framework will be coordinated by the Ministry of Energy. Table 12 summarizes the proposed M&E framework for Mongolia's SREP IP. Mongolia has nearly 100% access to electricity and therefore access to modern energy services; the use of renewables is proposed to improve energy independence and to reduce the cost of supply in future.

Table 12: Results Framework

Results	Indicators	Baseline	Targets	Means of Verification
SREP Transformative Impacts				
Support low carbon development pathways	RE capacity (MW) and annual electricity output (GWh/y) of hydro <10MW	Capacity: 50 MW [a] Output: 120 GWh/y [a]	Capacity: 630 MW by 2023; 1085 MW by 2030 Output: 1 200 GWh/y by 2023; 2 400 GWh/y by 2030	Ministry of Energy
	Increased annual public and private investments (US$) in targeted subsector(s)	$110million [b]	> $350 million[c] by 2023 $ 1 billion by 2030	Ministry of Energy
SREP Program Outcomes				
1. Increased supply of renewable energy	Annual electricity output from RE as a result of SREP interventions			SREP Projects M&E Framework
	Installed capacity	0	25 MW	
	Design Output	0	40 GWh/y	
2.New and additional sources for renewable energy projects	Leverage factor (US$ finance from other sources compared to SREP funding)	0	1.2 [d]	SREP Projects M&E Framework

GWh/y = gigawatt-hour per year, M&E = monitoring and evaluation, MW = megawatt, RE = renewable energy, SREP = Scaling-up Renewable Energy for low-income countries Program.

Notes:

[a] Salkhit Wind Farm, SHS, small hydro; does not include hydro > 10MW

[b] Assumes $2.2 / watt installed cost for Salkhit wind farm. Does not include existing SHS or small hydro.

[c] Assumes Sainshand, Tsetsii and Choir windfarms as committed, WES 25MW supported by SREP; estimated at $2.2 / watt installed cost.

[d] When Phase 2 investments (scaling up and replication) are included the leverage ratio would be 4.1.

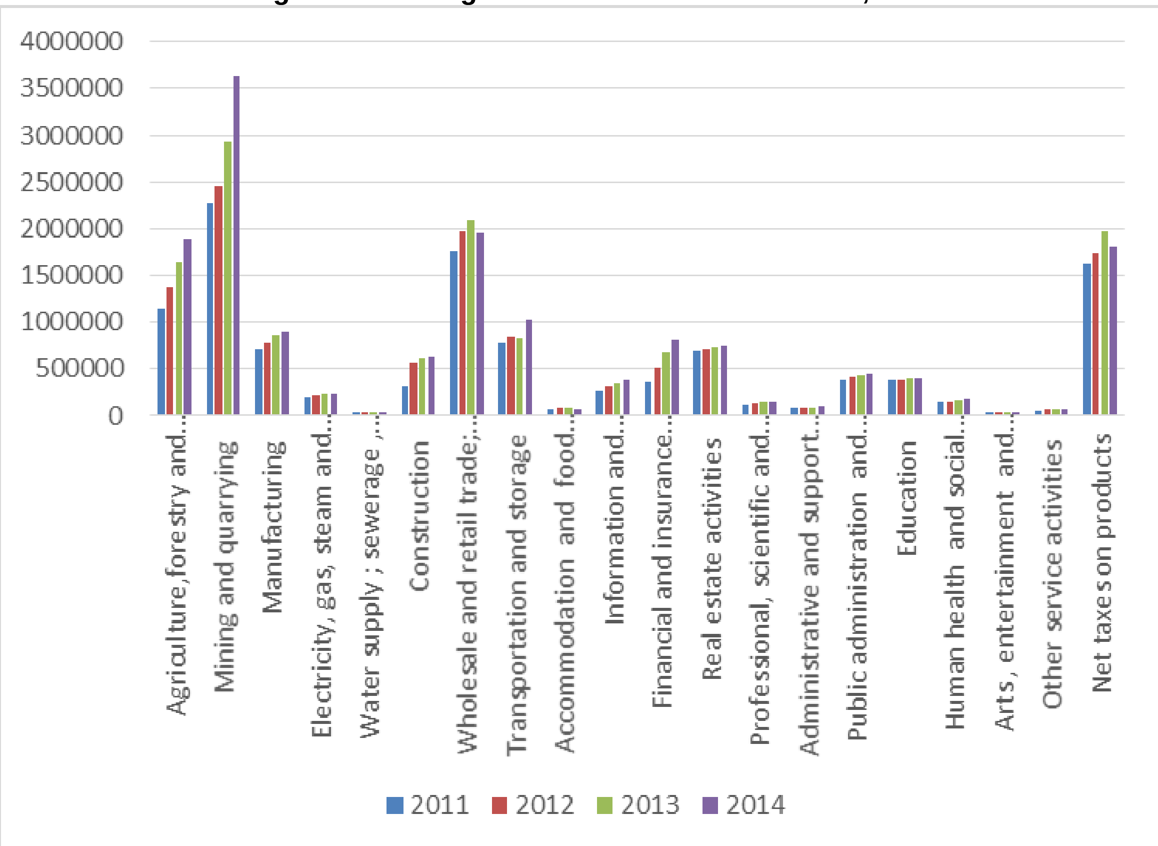
Source: Ministry of Energy estimates.

ANNEX A. ASSESSMENT OF COUNTRY ABSORPTIVE CAPACITY

Economic Outlook

1. Official reports of real GDP growth have been given as 17.5% in 2011, 12.3% in 2012, and 11.6% in 2013. Towards the end of calendar year 2013, the IMF reported that Mongolia's macroeconomic policies had become unsustainably loose. Pressure on Mongolia's balance of payments (BOP), compounded by negative shocks to FDI and coal exports were indicating a significant decline in growth. These concerns have played out, with a provisional estimate for GDP growth in 2014 of 7.8%. The decline has affected some sectors of the economy more than others; the growth in the mining sector increased from 19.5% in 2013 to 24% in 2014, largely due to the operations of the Oyu Tolgoi gold / copper mine but other sectors slowed or actually declined in the case of wholesale and retail trade sector. This decline is expected to have some impact on electricity consumption and indirectly on the development of renewable energy in Mongolia.

Figure A-1: Mongolia Gross Domestic Product, 2011-2014



Source: Energy Statistics of Mongolia (February, 2015).

2. According to a country report released by the IMF in March 2014, GDP growth was expected to follow one of two paths – a strong policy path or a weak policy path. The growth rates anticipated at that time are shown in the following table.

Table A-1: IMF GDP Growth and Policy Response

		2014	2015	2016	2017	2018
Strong Policy GDP (MNT billions)		6,730	7,201	7,576	8,220	8,713
		11.8%	9.6%	7.0%	5.2%	8.5%
Weak Policy GDP (MNT billions)		6,705	6,624	6,836	6,918	7,195
		11.8%	12.1%	-2.6%	-1.2%	3.2%

GDP = gross domestic product, IMF = International Monetary Fund.
Source: IMF (March, 2014)

3. The 2014 reported growth of 7.8% suggests that the 'strong policy' scenario has played out as expected by the IMF.

Debt Sustainability

4. According to the Debt Sustainability Analysis (DSA) jointly prepared by IMF and World Bank released in March 2015, Mongolia suffers from high risk of debt distress. Public debt stood at 77% of GDP, and will stay above the benchmark for almost the entire projection period of 2015-2035. Total external debt rose to 170 percent of GDP—reflecting, in large part, intercompany lending in the mining sector—undermining the economy's resilience to external shocks.

5. This assessment shows a significant deterioration of debt dynamics since the 2013 Article IV, which suggested a moderate risk under a "strong policy scenario."

6. IMF suggested the need to have a more pronounced policy tightening aside from the fiscal adjustment measures previously announced by the government in order to safeguard macro-financial stability and to ensure debt sustainability in case of adverse shocks. In order to strengthen Mongolia's fiscal position, the authorities have secured Parliamentary approval of the Amendment to the Fiscal Stability Law (FSL), Debt Management Law (DML), and the Comprehensive Macroeconomic Adjustment Program (CMAP). The government has revised Medium-term Debt Management Strategy and the Comprehensive External Debt Servicing Plan in accordance with the newly adopted Debt Management Law and the CMAP. Under the revised approach, the authorities will initiate active debt and liability management operations to ensure further debt is serviced or rolled over in a way that is consistent with macroeconomic stability.

7. However, with the newly passed Debt Management Law, public debt could rise further in the near term as the allows more room for the government to contract debt and guarantees.

Legislative Context

8. The operations of RE companies are governed by Law on Energy. It was enacted in 2001 to regulate Mongolia's energy generation, transmission, distribution, dispatching and supply activities, construction of energy facilities and energy consumption. The law re-established country's whole electricity sector operations based on un-bundling the previously monopolized operating entities. Energy Regulatory Authority (ERA), and since 2011 law amendment, Energy Regulatory Commission (ERC), was set up to be responsible for administering the provisions of the law. The commission issues the operational licenses, and reviews and approves tariffs of the sector actors. In accordance with the Law on Energy, the National Dispatch Centre and the National Transmission Company, have central roles in managing the RE operations.

9. A specific Law on Renewable Energy was adopted by the Parliament in January 2007. It aims to increase the utilization of renewable energy in Mongolia and to regulate the generation and the supply of renewable energy. The RE Law establishes the licensing procedures and the rights and duties of the distribution/transmission companies and the producers of renewable electricity

and heat. It also defines the characteristics of the power purchase agreement between the producers and the transmission companies.

10. Furthermore, the RE Law sets tariff/price ranges for wind, hydro (depending on capacity) and solar electricity generation by grid-connected and independent power generators. It also identifies the responsible authorities and defines the principles for tariff setting. According to the law, prices and tariffs of shall be stable for a period of minimum 10 years starting with the date of enforcement of the law. The producers shall be compensated for the difference between the production cost and the tariff through a Renewable Energy Fund. This fund shall be regulated by the law of Special Purpose Fund of Government.

11. Finally, there are important lower level regulation pertaining to RE development, including inter alia Grid code of National Electricity Transmission Network by the order of Minister of Energy, and the resolutions of ERC on (i) Licensing policy and regulations, (ii) The guideline for monitoring compliance with terms and requirement of license, (iii) The guideline for determining and reviewing tariffs.

Experiences of RE Regulation

12. The regulatory environment, and in particular, the RE Law of 2007 were able to create an environment in Mongolia, which immediately attracted a number of private sector developers to explore RE investment opportunities in the country. The energy purchase tariffs set by RE Law for different renewable energy technologies proved sufficient to trigger investment activities in line with the government RE targets. As a result, wind and solar developments detailed in Annex C, were licensed for construction and interconnection. Around 350 MW of wind power, of which 50 MW is in operation, and 50 MW of solar PV capacity have been licensed and are under various stages of development.

13. Mongolia is blessed with abundant renewable energy resources. In addition the country has positive prospects of growing demand for power, an acceptable RE Law with priority of dispatch to the RE generators, sufficient FiTs proven to trigger investors' interest, FiT expressed in US dollars thus mitigating macro-economic risk, and no particular planning or land constraints for RE development. However, many of the licensed projects have not proceeded quickly, have encountered problems with financiers' risk perception, and only few are about to start construction. Despite good basis and incentives, the country seems to be at risk of deviating from the positive trajectory of reaching her RE targets.

14. The experiences of Mongolia's first utility scale wind power plant, Salkhit 50 MW farm, which started operation in 2013 and was developed by Clean Energy LLC, a company owned 51% by Newcom, 14% each by European Bank for Reconstruction and Development (EBRD) and FMO – a Dutch development bank, and 21% by General Electric, have highlighted some weaknesses in the current regulation. Even with Mongolia's political commitment to RE development, there has been partly insufficient enforcement of regulation, such as, for example, that the foreseen RE Fund in the law was never populated with funds. In addition, some regulation includes ambiguities, which cause uncertainty in the market now that Salkhit experience has brought them to the fore.

Perceived Uncertainty about the Funds for FiT Payments

15. The RE Law stipulates under 11.2. "Any price difference of electricity generated by a renewable energy power source, connected to a transmission network, shall be absorbed in selling prices of other generators connected to the transmission network". Under 7.3.2., for independent power systems, they have right "To be compensated for a difference between end-user tariffs approved by the regulatory boards of Aimags and the capital city and cost from the Renewable Energy Fund."

16. In practice, the "single buyers account" has encountered difficulties to fully cover required

tariff difference for Salkhit project and as a result the income of the conventional power sources are reduced by certain level causing negative impact on financial sustainability of conventional power companies. Conventional power generators have therefore found new RE generator entrants inflicting financial risk for them.

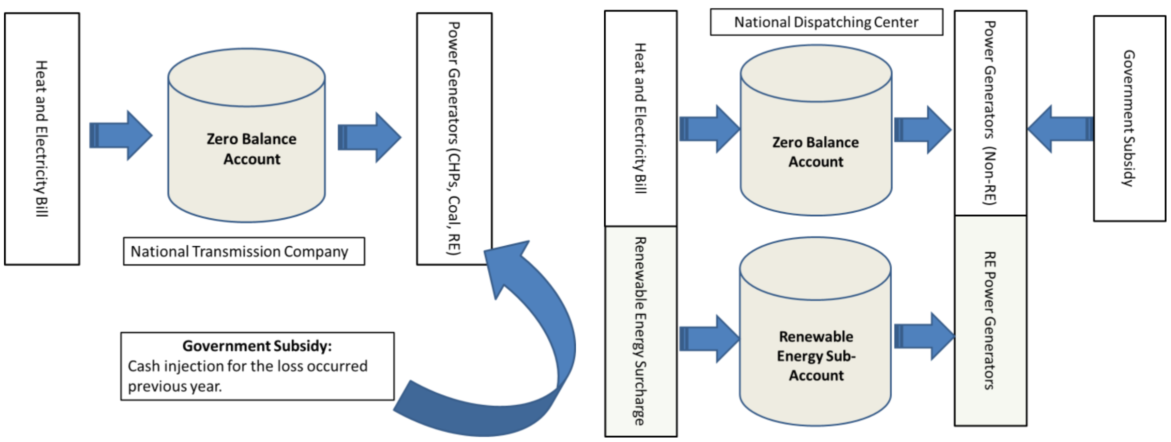
17. The lack of funding for FiT payments also negatively impacts the National Transmission Company who manages the Zero-Balance Account, from which the generators are compensated for their supplied energy. The FiT payments are reflected in the account holder's accounts so that the company's P/L account and balance sheet are negatively impacted. This in turn has a negative consequence on their financing other activities within their scope of operation such as improving grid infrastructure (lines, substations, SCADA etc.). Such negative aspiration of FiT expenses impacts not only the National Transmission Company, but also the transmission companies of WES and EES should RE projects be proposed within their respective regions.

18. The FiT payments are in practice reimbursed to the National Transmission Company in the form of direct subsidy from the government. This does not, however, remove the concern related to the negative impacts on the financial statements, which in turn may influence the ability of the company to borrow money and finance its operations. Again, the subsidy payments are not cash flow neutral with the FiT payments, and this causes another complication.

19. The FiT system has proven to be inadequately financed, and there has not been a sustainable and functional mechanism in place for covering the FiT payments. The Salkhit project has experienced delayed payments, and the investment community has perceived an increasing non-payment risk, which is further amplified by the known fiscal problems as a result of soft commodities markets, Mongolia's disputes with foreign investors and increasing external debt.

20. An amendment draft has been prepared to the RE Law and approved by the parliament in June 2015. The key amendment addressing the above problems is the proposed introduction of a (green) support surcharge on end-user tariffs. The support surcharge is planned to be used to establish a payment fund for renewable energy generators. Whilst at the present time a zero-balance account administered by the National Transmission Company is used to pay all generators in the Mongolian energy system, under the revised law, the National Dispatching Center (NDC) would take over the administration of the zero balance account. In addition a Renewable Energy sub-account would be created and administered by NDC. This account will receive the green energy surcharge revenue which will subsequently be used to pay renewable energy generators. In principle the proposed change to the law should have a positive impact on the development of renewable energy.

Figure A-2: Zero Balance Account and Renewable Energy Sub-Account



Renewable Energy Curtailment

21. The establishment of a maximum absorption capacity for renewable energy involves two technical problems. The first is related to the combined operation of wind farms, and solar PV farms in the CES, where RE is combined with a relatively inflexible thermal system dominated by coal fired CHP plants. The second issue relates to the long transmission lines that comprise Mongolia's transmission grid. Long lines give rise to technical difficulties to control the main operating parameters within safe limits under normal and emergency conditions.

22. With regard to the combined operation of the existing thermal power plants and new RE sources, the key constraints are summarized here. A detailed technical analysis of wind power curtailment in CES is presented in Annex D.

- CHP4 has not been designed to carry out load following, but is able to do it with limited capacity of variable RE supply in the system. It is estimated that the boiler operations of CHP4 can absorb wind power capacity in CES up to 125-175 MW.
- Solar energy is conducive from the system regulation point of view. Higher levels of solar energy feed to CES help to reduce boiler starts/stops during Spring, Summer and Autumn periods. Up to 250 MW of solar power can be accommodated without major impacts on system regulation by CHP4.

23. The main technical issue causing curtailment of especially wind energy is related to avoiding boiler starts and stops due to boiler minimum load conditions. Curtailed energy of Salkhit wind farm has been 8.8%, 3.3% and 9.1% of the delivered energy in 2013, 2014, and January-April 2015, respectively. The problems related to curtailment can be seen as (i) a commercial issue related to the system compensating for the non-supplied RE generation and (ii) a technical issue related to minimizing curtailment.

24. The commercial issue relates to the stipulations of the RE Law and PPAs. The relevant regulations include that the RE Law under clause 7.2.1 provides right to the RE generator to deliver its energy to the nearest connection point, and clause 8.1.1 obligates the system purchase electricity sold by a generator at a price approved by the Energy Regulatory Commission. Clause 10.1 gives the Energy Regulatory Commission right to impose a model PPA for the generator and the transmission licensee. Finally, Clause 7.2.3 obligates the generator to implement dispatching regulations requested by the dispatching licensee.

25. The interpretation of the above regulation has become an issue in Mongolia. The regulation can be read to rule that all energy supplied by RE generator must be accepted by the grid operator. The investors have interpreted this principle having been reflected in the PPAs (take-or-pay). On the other hand, the RE generator must follow the rulings of the dispatcher. The question has then remained whether or not the system must compensate the RE generator for the non-supplied energy due to curtailment order by NDC. Here, the government can solve the issue by an explicit ruling to be expressed in the model PPA for future projects. The investor community would then seek either the curtailed energy to be fully compensated or boundaries set to the un-compensated amount of curtailment.

26. The technical and operational issue related to curtailment are discussed in more detail in Annex E. However, from the system operational point of view, the current set up in the dispatch is not explicit and conducive to RE generators. The issues are as follows:

- CHP4 is, de facto, acting as the load following generator in the system, but it has no financial incentives to carry out this function. Vice versa, most load following actions requested by NDC from it due to intermittency of RE generation, have negative financial consequences to CHP4. Therefore, it is necessary to officially acknowledge the regulating role for CHP4 and create a mechanism under which it would be incentivized rather than penalized for carrying out load following and other such services to grid operations.
- The dispatching principles in the grid code need to be clarified. The 'least-cost' dispatch should be defined to mean either (i) marginal cost based least-cost dispatch, which would always ensure the dispatch of RES generation (if not prevented by technical constraints), or (ii) carbon based dispatch. Also provisions concerning "must-run" generation, whether based on heat-bound CHP or future hydropower plants, should be defined. A practical

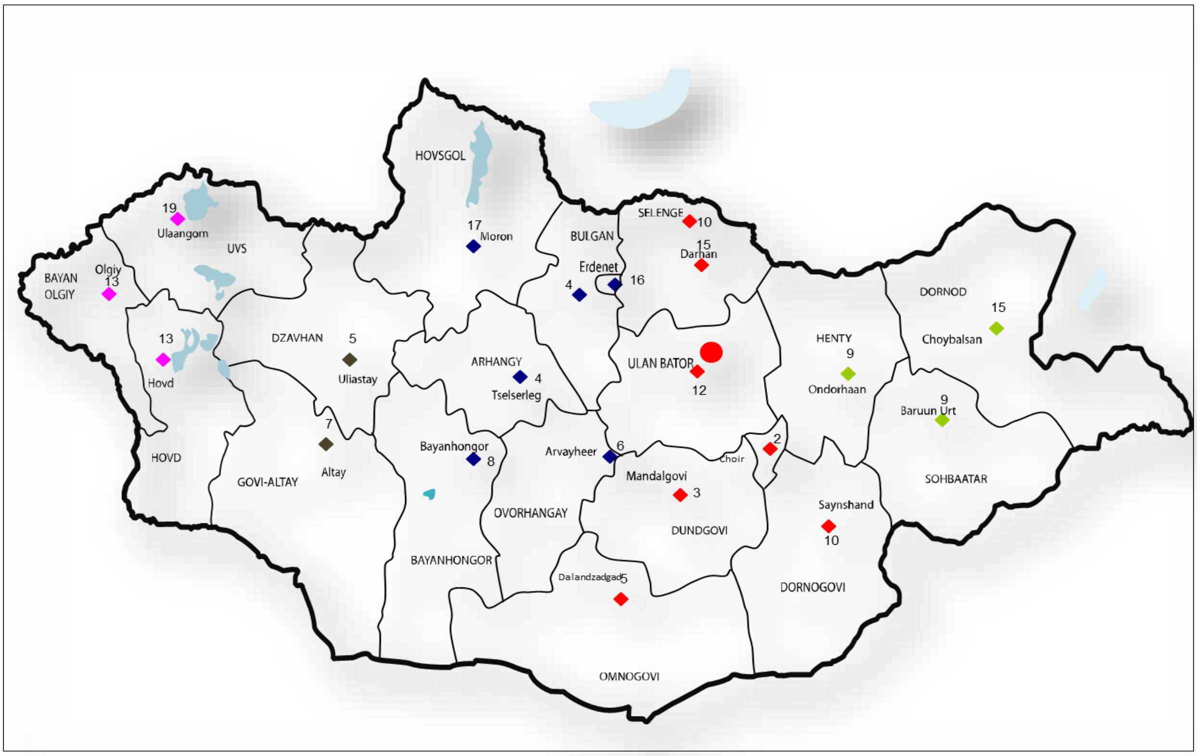
example of a consequence of the above is that NDC should prioritize wind generation over must-run cogeneration, if there is a chance for turbine by-pass in a CHP plant. At the moment, turbine by-pass is not imposed and there is no incentive for CHP plants to use it even in cases of oversupply of wind energy in the system.

- The penalties due to unscheduled imports from or exports to Russia have often been cited as the main reason to wind energy curtailment. This issue should first be addressed domestically by maximizing the utilization of domestic regulation potential in CHP4. CHP4 and the Ulaanbaatar district heating system would benefit of having low pressure heat accumulator(s) in the system, which would not only provide operational benefits for the city's DH system but also help to regulate power import/exports. Along with utilizing domestic opportunities for better regulation, the government is encouraged to seek better flexibility to the operation of the export/import line with the Russian counterparty in the changed situation with higher amount of wind energy in Mongolia's system.

27. In mid- to long term, it is important to speed up implementation of the proposed project of a hydropower plant (Egiin Gol 315 MW, Shuren 245 MW) that could provide regulating power capacity to balance the power system.

28. Mongolia's transmission grid is characterized by its long transmission lines supplying small, scattered loads across the country. With the exception of the main towns of Ulaanbaatar, Erdenet and Darkhan, loads are relatively small but separated by large distances. Analysis undertaken by the National Despatching Centre in 2013 showed that in some regions, including Ulaanbaatar, the maximum loads approach the limits of stable operation. This means that the capacities of new RE schemes may be constrained in some cases. The nature of this technical problem is such that analysis must be undertaken on a case-by-case basis; in the case of large wind power a key issue is the ability of wind turbines to ride-through disturbances on the main transmission network.

Figure A-3: Aimag Centre Demands, 2013
(MW)



Licensing Ambiguity

29. The RE Law together with the Energy Law use wording which implies that licenses for the

construction of RE plants and for electricity generation in the plants "shall be granted" should the necessary conditions be fulfilled. There is no indication that the government would seek to restrict the number or capacity of licensed RE operators. Several RE plants have already been granted licenses, but not all of the projects have proceeded to implementation.

30. The perceived ambiguity in the licensing practice relates to the known fact that the absorption capacity of the grid, as it is today without hydropower, is limited, and the revenue uncertainty. Therefore, whilst the government commitment to the RE targets is acknowledged, its ability to enforce the law and allow all licensed projects to proceed to implementation is questioned.

31. The openness of the legislation to accept applications from investors for RE generation, and the set targets for RE generation in 2020 and 2030 demonstrate clear political commitment of Mongolia to increase the share of RE in its energy mix. However, whilst the political will has been demonstrated not all institutional and economic aspects of the RE policy have possibly been considered. The fiscal limitations, on the one hand, and the technical constraints, on the other hand, will set rather definite restriction for the short-term implementation of large utility scale RE projects. This is, however, not 'officially' acknowledged nor is there a mechanism to communicate about such restrictions to the investment community.

32. With the purpose of maintaining investor confidence, it would be essential to develop criteria for rejecting RE applications for licenses in cases the target levels for RE are exceeded. Furthermore, the government is encouraged to consider establishing suitable time-bound incremental targets for new RE plants, which would then guide the intensity of the investors' project development work. In this context, the government should consider whether or not legislation could be adjusted to allow government announced fixed RE portfolios, and consequential auctioning construction and generation licenses to achieve RE targets at optimized cost and time.

Access to Commercial Financing

33. A survey of private sector RE developers was undertaken in March 2015. A number of the developers cited difficulty accessing commercial financing in Mongolia. However, whilst the access to financing remains an issue the banking sector overall grows and develops favorably. The volume of the retail and corporate loans increase annually by about 40 % (Bank of Mongolia, 2014).

34. The main barriers of financing RE in Mongolia are high interest rates and high collateral costs. In this context, most utility scale RE projects have sought and secured concessional financing from international financing institutes either directly or through their domestic partners.

35. The current policy interest rate of Bank of Mongolia is 13%. The annual inflation has decreased from around 14 % in 2014 to 8 % in May 2015. Due to currency exchange fluctuations, high inflation, and an unstable policy environment, the variation in the interest rates of MNT denominated loans varies highly, from 5 % to 42 %. The average loan interest rates for RE investments by small businesses or consumers can be estimated at around 22% per annum with high collateral requirements and short loan tenure (XacBank).

Sustainable Operation (O&M)

36. As mentioned above, Mongolia is a large country with generally small dispersed populations. The aimag centre and soum centres are characterized by the large distance between small populations and associated small electrical loads. The small loads and large distances increase the costs of the supply of electricity over a grid network. While the majority of Mongolians have grid access, the replacement of the transmission and distribution network with age means that there is a significant ongoing cost. Given these factors the potential to use renewable energy sources and micro-grids appears to be significant - provided they are grid connected.

37. History of many rural electrification projects with independent RE systems shows that there

have been difficulties in operating and maintaining renewable energy schemes at the soum level due to lack of trained personnel. The World Bank supported Renewable Energy and Rural Electricity Access Project (REAP) facilitated (2006-2011) the rehabilitation of 15 out of the 30 mini grids in soum centers, installed 11 out of 20 renewable-diesel hybrid systems, and saw five other soums connected to the main power grid. However, the operating experience of these systems did not perform to the satisfaction of the planners and population alike, and the government then proceeded quickly with the grid electrification of all soum centers in the country.

38. This suggests that renewable energy systems should be applied at large soum centres, where the distribution system supplies other smaller soum centres, or at aimag centres, and in today's reality, be grid connected. Alternatively, RE generation facilities should be developed to the vicinity of substations or other power generation facilities. In such cases it can be expected that trained O&M technicians can be drawn from local distribution or transmission companies, or from among wider local population.

Ability to Pay

39. In 2015, the average household tariff was around 108 MNT/kWh (5.0 USc/kWh). In addition, there are special tariffs for low income families in progressively priced consumption categories depending on the monthly use. For the first consumption category (150 kWh monthly depending on location) the tariff was 98.4 MNT/kWh .

40. International comparison clearly indicates that the electricity tariffs in Mongolia are substantially lower than in other medium-income countries of Asia. In US cents terms, the Mongolian average tariff quoted in the Yearly Statistical Book of ERC was 6.6 c/kWh as compared to 9.4 c/kWh in Thailand or 10.5 c/kWh in the Philippines.

41. According to a recent Household Socio-Economic Survey first quarter of 2015, the average annual household income is 11.3 million MNT. The affordability criterion monitored by the regulator is that the level of electricity and heat expenses for households should not exceed approximately 10 % of the total household's income. This represents about MNT 940 000 annually in average. The annual heating bill of a four person household can be estimated at around MNT 220 000 (at 9,085 MNT/GCal, 24 Gcal/hh/a), which leaves 720,000 MNT for electricity corresponding to 6700 kWh/a annual household consumption.

42. Whilst the heat and electricity demands of households vary significantly, the 10 % affordability criterion can be seen to provide adequate energy service levels for an average household in Mongolia. Consequently ability to pay is not an issue on average basis but it is topical for the population in distant soums, herders and urban poor. The poverty headcount ratio of Mongolia is 27%. In Khuvsgul aimag, which is the second poorest in Mongolia, the GDP per capita is about 50%, and the mean annual salary about 80% of the national average. Ability to pay therefore is a significant barrier to stand-alone RE systems in remote areas. With all soum centres now grid connected, this hurdle remains in the outskirts of the population centers and among herders with no permanent electrified dwelling in towns.

43. The REAP (Renewable Energy and Rural Electricity Access Project) observed great difficulties with herders' self-financing portion of solar home systems as they were expected to provide 50% of the RE system costs themselves. With many having cash earnings of $300 to $400 a year, the required amount represented half of their annual income. Even before the project commenced, surveys with herders found that most would not have been able to purchase even a basic 20Wp system. However, most herders expected more than just lighting, and hence substantially higher capacity solar systems. Anecdotal evidence from the project has indicated that when the minimum energy service levels are not fulfilled, there is a higher likelihood of the system being poorly maintained and ultimately rejected.

ANNEX B. EXISTING ACTIVITIES IN THE FIELD OF RENEWABLE ENERGY

Annex B presents details of private sector development activities and parallel development (donor activities).

Private Sector

Wind Power Current Status of Development

1. There are five active wind power projects totalling 350 MW of capacity as follows:-
   - Oyu Tolgoi Wind Power Project by Qleantech LLC, 102 MW
   - Sainshand Wind Park, Sainshand Wind Park LLC, 52 MW
   - Choir Wind Farm, Aydiner Global LLC, 50.4 MW
   - Tsetsii Wind Farm, Clean Energy Asia LLC, 50 MW
   - AB Solar Wind , AB Solar Wind LLC, 100 MW

2. All have government approval and their readiness allows construction to starts in 2016, only the Tsetsii Wind Farm project does not yet have an approved tariff. The Sainshand and Choir projects have applied for SREP funding for the substation expansion on the Transmission Company's side but this has not been included in the IP.

3. All of the above projects are commercial in nature and feasible without SREP financing. In principle once institutional issues related to Feed-in-Tariff payments, dispatch order and curtailment, and issues related to substation expansion are resolved, the projects can proceed on their own merits.

4. Table B1 provides details of the current status of wind power development in Mongolia.

Table B-1: Current Status of Wind Power Development

Project Name	Project Developer	RE Technology	Install Capacity (MW)	Annual Yield (MWh)	Total Cost (Million US$)	Location (soum, aimag)	Project Status				Financier (If any)	Target Commissioning Year	Energy off-taker
							Feasibility study	Special License	PPA	Tariff			
Oyu Tolgoi Wind Power Project	Qleantech LLC	Wind	102	370	200	Khanbogd, South Gobi	Approved by MoE	Yes	Yes	0.095	Suntien Green Energy; Chinese loan	2016	Central Energy System
Sainshand Wind Park	Sainshand Wind Park LLC	Wind	52	200,000	110	Sainshand, Dornogovi	Approved by MoE	Yes	Yes	0.095	Project finance Ferrostaal + others	2016	Central Energy System
Choir Wind Farm	Aydiner Global LLC	Wind	50.4	123,000	100	Sumber, Govisumber	Approved by MoE	Yes	Yes	0.095	Project finance	2016	Central Energy System
Tsetsii Wind Farm	Clean Energy Asia LLC	Wind	50	142,000	118	Tsogttsetsii, South Gobi	Approved by MoE	Yes	Yes	0.094	30% Equity Newcom, SB Energy; 70% Loan JICA	2016	Central Energy System
AB Solar Wind	AB Solar Wind LLC	Wind	100	200,000	170	Dalanjargalan, Dornogovi	Approved by MoE	Yes	Yes	0.095	Chinese investors	2016	Central Energy System

JICA = Japan International Cooperation Authority, LLC = , MoE = Ministry or Energy, MWh = megawatt-hour.

Hydropower Current Status of Development

5. In addition to the abovementioned large hydropower schemes, there is a well-specified project proposal for the Maikhan Small Hydropower Station, Usny Erchim LLC, 8 – 12MW; the Feasibility Study has been approved by the government; PPA negotiations have been on-going. There is an environmental issue mentioned in connection with the Maikhan project, which is of such significance that the government has yet to be convinced that the project should be approved.

6. Table B-2 below provides further details of all hydropower schemes currently under development and their current status.

Table B-2: Current Status of HPP Development

Project Name	Project Developer	RE Technology	Install Capacity (MW)	Annual Yield (MWh)	Total Cost (Million US$)	Location (soum, aimag)	Project Status				Financier (If any)	Target Commissioning Year	Energy off-taker
							Feasibility study	Special License	PPA	Tariff			
Ulaanbaatar Pumped Storage Power Station	Ulaanbaatar Pumped Storage Power Station LLC	Hydro Pumped Storage	100	300,000	285	Ulaanbaatar	Approved by MoE	Yes	In progress	0.113	15% Developer; 5% EPC contractor; 80% loan	2020	Central Energy System
Egiin Hydro Power Plant	Ministry of Energy	Hydro	315	606,000	827	Khutga Undur, Bulgan	Approved by MoE	No	In progress	No	To be funded through loan from Chinese government	2020	Central Energy System
Shuren Hydro Power Plant	Ministry of Energy	Hydro	245	930,000	780	Tsagaannuur, Selenge	In progress	No	No	No	Project finance	2020	Central Energy System
Chargait Hydro		Hydro	24.6	116,000	95.6	Toson, Khuvsgul	Approved by MoE						Western Energy System
Orkhon Hydro Power Plant		Hydro	100	216,000	160		No						
Hovd Hydro Power Plant	ZTM	Hydro	88.7	418,800	160	Ulgii, Bayan-Ulgii	Approved by MoE				ZTM		
Erdenburen HPP							Approved by MoE						
Maikhan Hydro Power Plant	Usny Erchim LLC	Hydro	12	45,000 - 57,000	14.2	Tsengel, Bayan-Ulgii	Approved by MoE	No	In progress		Project finance	2017	Western Energy System

HPP = hydropower plants, LLC = limited liability company, MoE = Ministry of Energy, MWh = megawatt-hour, PPA = Power Purchase Agreement.

Solar PV Current Status of Development

7. There are seven active solar PV power projects under development, all grid-connected and for a total of 128 MW, developed by the private sector, as follows:

- Galbiin Gobi, Solar Ilch LLC, 50 MW
- Desert Solar Power One, Desert Solar Power One LLC, 30 MW
- Taishir HPP Solar Power Plant, Huduugiin Tsahilgaan LLC, 10 MW
- Altai Solar Power Plant, "Saisan LLCMyclimate“, 10 MW
- Darkhan 10MW Solar PV Plant, Solar Power International LLC, 10 MW
- Sumber Solar Power Plant, ESB Solar Energy Co.,Ltd., 10 MW
- Bayanteeg Solar Power Plant, Mon-Korea Engineering LLC, 8 MW

8. All of these projects except Galbiin Gobi have had their FS approved by the government, but none has an approved tariff.

9. Galbiin Gobi (50 MW) and Sumber Solar (10 MW) have approached the consultant for SREP financing but the intended use is unclear.

Table B-3: Current Status of Solar Photovoltaic (PV) Development

Project Name	Project Developer	RE Technology	Install Capacity (MW)	Annual Yield (MWh)	Total Cost (Million US$)	Location (soum, aimag)	Project Status				Financier (If any)	Target Commissioning Year	Energy off-taker
							Feasibility study	Special License	PPA	Tariff			
Galbiin Gobi	Solar Ilch LLC	Solar PV	50	94,240	140	Khanbogd, South Gobi; TBD, South Gobi	In progress	In progress	In progress	In progress	Project finance	2017	Mines in South Gobi region; Central Energy System
Desert Solar Power One	Desert Solar Power One LLC	Solar PV	30	52,000	70	Sainshand, Dornogovi	Approved by MoE	Yes	In progress	No	Project finance	2016	Central Energy System
Taishir HPP Solar Power Plant	Huduugiin Tsahilgaan LLC	Solar PV	10	14,000	22-24	Taishir, Govi-Altai	Approved by MoE	Yes	No	No		2017	Altai Uliastai Energy System
Altai Solar Power Plant	Saisan LLC Myclimate	Solar PV	10	15,000	26.8	Esunbulag, Govi-Altai	Approved by MoE	No	No	No	JCM; Commercial banks	2016	Altai Uliastai Energy System
Darkhan 10MW Solar PV Plant	Solar Power International LLC	Solar PV	10	15,200	19.6	Darkhan city	Approved by MoE	Yes	In progress	No	Solar Power International LLC; Sharp Corporation	2016	Central Energy System
Sumber Solar Power Plant	ESB Solar Energy Co.,Ltd.	Solar PV	10	17,493	22.5	Sumber, Govisumber	Approved by MoE	In progress	In progress	Negotiation in progress	Developer - 20% Other sources - 80%	2016	Central Energy System
Bayanteeg Solar Power Plant	Mon-Korea Engineering LLC	Solar PV	8	13,158	24.2	Nariinteel, Uvurkhanga i	Approved by MoE	No	No	No	Shin Sun Solar Energy LLC	2015	Central Energy System

LLC = limited liability company, MoE = Ministry of Energy, MWh = megawatt-hour, PPA = Power Purchase Agreement, PV = photovoltaic.

Parallel Development (Donor) Activities

Table B-4: Key Parallel Development Activities

Agency / Activity	Timing	Relevance to SREP IP
GIZ building retrofit program: insulation and other upgrades to make buildings more energy efficient.	Ongoing	The retrofitted buildings will be considered as the highest priority for the heat pump installations.
Xac Bank financial intermediation for clean energy development	Ongoing	Sustainable energy financing facility could be expanded based on SREP co-financed project results and availability of additional concessional funds in Phase 2.
ADB Western Region Roads	Ongoing	Road development supported economic development and energy demand growth; will also facilitate transport and installation of RE and heating systems

ADB = Asian Development Bank, IP = investment plan, SREP = Scaling-up Renewable Energy for low-income countries Program.

ANNEX C. SUMMARY OF STAKEHOLDER CONSULTATION

1. Two public workshops were held during the preparation of the SREP IP, to solicit feedback from stakeholders, including government, private sector, civil-society representatives, and other development partners. The SREP objectives were presented and the country context and RE development activities were discussed to determine the need and potential uses for concessional finance in RE development.

Workshop – March 2015

2. The first workshop was held in March 2015. Expressions of interest were solicited from the private sector including project developers and financial institutions. Of the five wind power projects under active development (see Annex B), two requested support from SREP (the Sainshand and Choir projects) ensuring the grid connection. However, the intended use of funds was for the substation expansion (i.e., on the transmission company's side) which is not normally directly supported by SREP. The wind projects were judged to be feasible without SREP financing – once the institutional issues related to FiT payments, dispatch order, curtailment and substation expansion are resolved – the projects can proceed on their own merits. Of the 7 solar PV projects under development (see Annex B), the 50 MW Galbiin Gobi and 10 MW Sumber Solar developers expressed interest in SREP support but did not provide specifics on the use of funds. These solar projects are also considered to be financially viable under the existing FiT system.

3. The proposed 12 MW Maikhan Small Hydropower Station, Usny Erchim LLC, also expressed interest in SREP funds. The Feasibility Study has been approved by the government; PPA negotiations are on-going. From a least-cost planning point of view, the project is attractive and would be a desirable addition to Western Energy System, as it would be able to balance intermittent wind and solar power (complementing the proposed SREP investments). However, there is an environmental issue concerned with use of water from a lake without inflow. Also, the project capacity has not been confirmed: it may be only 8 MW, but a 12 MW installation would not be eligible as SREP is limited to hydro projects no greater than 10 MW.

4. Xac Bank proposed a small and medium scale enterprise (SME) Renewable Energy Financing Facility, which would utilize $3.5 million in grant funds to allow the bank to lower two of the largest barriers for clients seeking renewable energy solutions: (1) high interest rates and (2) high collateral costs. Xac Bank proposed a pilot loan facility for lending to SMEs and corporate clients either producing or purchasing renewable energy products, as well as micro-loans to families looking to buy renewable products. Xac Bank has established sustainable energy financing facilities with support from EBRD, IFC, and the Global Climate Partnership Facility (GCPF). The concept presented by Xac Bank is attractive in the SREP context, but at present there is no viable prospect for integrating the concept into multilateral bank operations.

5. These hydro, solar, and wind projects and the proposed financing facility can all be considered in Phase 2 with support from other funding sources.

Table C-1: List of Participants during the Consultation Workshop, March 2015

Name	Organization
N. Nyamdorj	Ministry of Industry
B. Chimgee	
Ts. Bayarkhuu	Ministry of Education, Culture and Science
O. Munkhbayar	
Uranbileg	
E. Davaanyam	Ministry of Food and Agriculture
S. Zorigt	Ministry of Foreign Affairs

Name	Organization
Ts. Tumentsogt	"General Electric" LLC
S. Badral	"General Electric" LLC
B. Bayasgalan	"General Electric" LLC
E. Bilguun	"Malchin" LLC
D. Ulziisaikhan	"Usnii Erchim" LLC
D. Khandmaa	"Usnii Erchim" LLC
R. Davaanyam	"Sainshand Wind Park"
D. Nandinbayar	"Sainshand Wind Park"
T. Chingis	"Sopoko" LLC
S. Manlai	"Sopoko" LLC
Kh. Enkhjargal	The Mongolian University of Science and Technology
Ya. Avirmed	Academy of Physics and Technology
S. Sainbold	Academy of Physics and Technology
B. Batlkhagva	"Monhorus" LLC
B. Byambadorj	"Monhorus" LLC
S. Batchuluun	"Sobby" LLC
Ts. Tsolmonbaatar	"Steppesolar"
L. Sergelen	"Natural Energy Resource" Corporation
L. Erdenedalai	"Mon-Energy Consulting" LLC
Sh. Batrenchin	"Mon-Energy Consulting" LLC
A. Erdenebaatar	"Aidyner Global" LLC
Batbayar	"Monmar" LLC
S. Khurelbaatar	"Sankou Solar" LLC
O. Batgerel	"Sankou Solar" LLC
E. Myagmardorj	"Qleantech" LLC
D. Tumurbat	"Qleantech" LLC
N. Purevdagva	"Clean Energy Asia" LLC
G. Tuul	Xac Bank
Noah. E	Xac Bank
G. Purevdorj	Energy Association
Yo. Gantogoo	Energy Association
Oliver Schnorr	"Ferrostaal Mongolia" LLC
B. Jargalsaikhan	"Terra Global"
B. Achitsan	"Terra Global"
A. Lkhamsejid	Ministry of Construction and Urban Development
Peter Pemelton	"Carbonbury" (???)
D. Purevsuren	"Clean Energy Consulting" LLC
Ts. Sukhbaatar	"Clean Energy" LLC
P. Jamiyandorj	"Clean Energy" LLC
Ts. Oyungerel	"GDF Suez Mongolia" LLC
Thierry Cardinael	"GDF Suez Mongolia" LLC

Name	Organization
Amarbayar	"JPower" LLC
D. Bayasgalan	
B.Batdelger	"Grand Power" LLC
Harrison Smith	"NovaTerra" LLC
Buyanbat	
Erdenebileg	
M. Enkhtsetseg	"Bodit Chadal" LLC
N. Chogsomdorj	"Irradians" LLC
S. Burentsogt	
B. Narmandakh	
N. Enebish	"Solar Power International"
B. Mandalbayar	
T. Orgilbold	"MCS International" LLC
L. Jambaa	ERC
Uyanga	Mongolian Radio
Ts. Gerelt-Od	Ministry of Environment, Green Development and Tourism
Ch. Munkhzul	
Erdenetuya	Ministry of Finance
Ts. Dorjpurev	"EEC" LLC
Enkhkhuyag	Development Bank of Mongolia
E. Munkhbileg	Ministry of Energy
B. Osorgarav	"Mon-Nor Engineering" LLC
Kim John	"Shin Sun Solar Energy" LLC
Cal Jon Yun	
I Yan Am	
S. Balubaatar	
Michael Emmerton	ADB consultant team
O. Bavuudorj	
Sakari Oksanen	
Oyundari. Sukhbaatar	National Dispatching Center

Workshop – August 2015

6. The public workshop held in August 2015 explained the SREP IP proposal to all interested stakeholders (the same attendees to the March 2015 workshop were invited to the August workshop). The government explained their preferences, the ADB SREP consultants made presentations to explain the process undertaken in developing the IP, from solicitation, idea generation, through screening. The government representatives explained their RE policy and explained the rationale for selection of the components in the proposed IP. There was strong support expressed for the IP proposal by the attendees.

Table C-2: List of Participants during the Consultation Workshop in August 2015

Name	Organization
U. Myagmardorj	Wind energy Association Mongolia

Name	Organization
E. Myagmardorj	
Matthew Le Blan	EBRD
Dagvadorj	"Usnii Erchim" LLC
Khandmaa	
Batrenchin	"Mon-Energy"
Altangerel	NREC
S. Yamamura	ADB
Michael Timm	GIZ
Jiwan Acharya	ADB
Chadraa Batbayar	"Chingis Energy"
B. Bolor-Erdene	УТБЗХ
Dan Millison	"Trancenderay" LLC
M. Tumenjargal	Ministry of Energy
B. Yeren-Ulzii	
G. Tuul	Xac Bank
Nathan Johnson	USA Embassy
Zayabantu	"Rpama" LLC
S. Khurelbaatar	"Sancou solar Mongolia"
Kh. Enkhjargal	MUST
J. Dorjpurev	EEC
G. Tuvshinjargal	Ministry of Environment, Green Development and Tourism
Ts. Gerelt-Od	
T. Khishigt	"Newcom" LLC
A. Erdenebaatar	"Aidyner Global" LLC
Munkhtulga	ERC
Roberto La Rocca	World Bank
G. Gerelmaa	ERC
Michael Emmerton	ADB consultant team
O. Bavuudorj	
Sakari Oksanen	

ANNEX D. RENEWABLE ENERGY CURTAILMENT

Background

1. The issue of curtailment is critical for the future development of utility scale wind farms and solar PV fields in Mongolia. The first large scale wind farm in the country, Salkhit 49.6 MW facility encountered a requirement to curtail 6% of its potential output during the first year of operation. This experience is bound to discourage on-going and new wind power developments in the country, especially as compensations related to curtailed energy as well as issues related to the amount of energy that wind power companies are expected to be ready to curtail, have not been resolved. Such deterrence counters the goals of Mongolia's Renewable Energy Law.

2. The curtailment issue can be approached from two perspectives. One is to estimate from a technical and operational point of view the likely level of curtailment, because the thermal power plants of the country have limited load following capabilities. The second is to understand the regulatory and financial setup that guides the operation of the dispatch centre, and whether there are rules embodied in the current dispatch practices, which work against increasing application of renewable energy in the country or set disincentives either to RE producers or CHP4, the primary plant responsible for load following.

3. It should be noted that *the simulated curtailment in the following represents merely the amount of wind and solar energy not-produced in the event CHP4 is not obligated to operate differently than the set curtailment criteria in the simulation.* The curtailment criteria are fixed and set by the Consultant so that they would represent a typical response to a typical decision making situation in the power plant. However, in real day-to-day plant operation decisions can be made flexibly, case by case considering the merits of closing down or starting a boiler. The resulting wind curtailment of the simulation is therefore not an unconditional number but its real life equivalent is subject to operational consideration and commercial decisions by the operators and regulatory agencies.

4. The current dispatch rules are not based on marginal costs but on average tariffs set by the government regulators. The true cost of coal-fired generation, even ignoring the CO_2 externality, is understated in the tariffs whereas the marginal cost of wind generation is perceived on basis of its Feed-in-Tariff, which not only includes all costs of the developer (including investment costs and profits), but also the incentive premium that the government has decided to set when enacting the Renewable Energy Law. Attitudinally, not all operators in the Mongolian power system have recognized the nature of wind and solar as nearly zero variable cost energy and the potential of wind and solar energy to address a looming electricity supply shortfall of the country.

System Context

5. Mongolia's power system has the specific feature that it is inextricably linked to the heating system operation. Winter is long and average daily temperatures frequently fall in the range of minus 20ºC to minus 30ºC. Stable heat supply is a matter of human survival. Heat and power generation hour-by-hour are physically linked to each other by the fact that a major share of heating demand is covered by combined heat and power plants (CHP), which provide electricity, heat and hot water in Ulaanbaatar and other large cities.

6. The country's energy policy rightly has sought resource efficiency by establishing large district heating systems connected to supply from the CHP plants. Central heating systems in Ulaanbaatar, Darkhan, Erdenet and Choibalsan are an integral part of the energy sector and supply nearly 40 % of the urban heat demand. Ulaanbaatar has three CHP plants, CHP2, CHP3 and CHP4. Smaller towns also have district heating systems but supplied mostly by heat-only boilers. Heat demand growth has been high in recent years and demand forecasts are based on growth of

up to 3% annually.

7. CES is supplied with electricity by five CHP plants, plants 2, 3 and 4 in Ulaanbaatar and Darkhan and Erdenet plants. Choibalsan is connected to EES. CES is connected to Russian national grid via a 220 kV transmission line. Main features of the CHP plants are summarized below:

Table D-1: Summary of CHP Plant Capacities

Plant	Typical Turbine Unit	Number of Boilers	Number of Turbines	Nominal Electric Capacity (MW) *)
CHP 2	Three units of different kinds	5	3	24
CHP 3	Two sections, Low Pressure PT12 and High Pressure PT-25	6 (LP) + 7 (HP)	4+4	148
CHP 4	PT-100 (one PT-80)	8	5+1	580
Darkhan	PT-12	9	4	48
Erdenet	PT-12	7	3	36
Total		**42**	**24**	**824**

CHP = combined heat and power, HP = high pressure, LP = low pressure, MW = megawatt, PT = power turbine.
Note : Maximum capacity is dependent on heat load and supply of process steam. Available capacities of CHP2 and CHP3 are lower due to deterioration. Additional unit of 50 MW to CHP3 and 100 MW to CHP4 planned for 2014.

8. The energy system of Mongolia is more homogenous than in most countries, where the fuel base is more diverse and a wider range of power generation technologies is present. Mongolia currently lacks access to moderately priced liquid fuels and there is no natural gas network. Mongolia has hydropower resources but those have not been harnessed in large scale. Therefore there are no storage type hydropower stations nor fast responding gas or oil fired gas turbines or engine type power plants, which typically have a role in responding to load variation. Mongolian power system is relatively rigid in terms the plants' ability to adjust to varying loads.

9. CHP2, CHP3, Darkhan and Erdenet plants have very limited capability to adjust to load variations. The control and instrumentation systems of the plants have not been built with this purpose in mind, and the physical regulating space in the turbines is very small. CHP4 has been designed to operate in a load following mode. However, it is also based on pulverized coal combustion technology which provides limited ramping capability and slow start-ups from cold state of boilers. Therefore all fast ramping requirements and spinning reserve for frequency control takes place by the Russian grid, to which CES is connected.

10. The maximum import capacity from Russia to CES is 210 MW and it is likely to increase to 250 MW. At present up to 130 MW is being imported during peak hours. On the other hand, during cold winter nights, when electricity loads are low but heat loads are high, there is excess generation of electricity from the CHP plants which is exported to Russia. Russia has a functioning wholesale electricity market with both energy and capacity compensation systems. The import tariff applicable to Mongolia reflects the same rules as given to large electricity consumers in Russia with the exception of penalties imposed on unscheduled energy deliveries. Given that the geographic conditions in Russia in the region of the import/export connection are quite similar to those on Mongolian side of border, exporting from Mongolia to Russia occurs at times, when the marginal cost of electricity is very low on Russian side too. Such export is poorly compensated. The operating regime of the cross-border transmission line therefore calls for reserving its capacity solely for the system regulation purposes and minimizes commercial import/export transactions. Keeping the import within the scheduled limits is a key task of the National Dispatch Centre (NDC) of Mongolia.

11. The Mongolian transmission grid is characterized by long transmission lines with constraints on power flow capacities. In the case of the Ulaanbaatar transmission grid, there is instability under first contingency fault conditions. In other cases, instability will arise in a matter of years as power transfer increases. The key point to recognize is that large grid-connected wind or solar PV farms cannot be connected to the existing transmission network without considerable investment in transmission capacity. Conventional power plant development also requires transmission expansion, but such technologies generally operate at high capacity factors and transmission

investment can be spread over more units. In other words, the need to invest in transmission networks penalizes grid-connected RE schemes compared to conventional power plants.

12. Renewable energy (RE) in Mongolia will be developed in this context. Renewable energy plants will set some specific change requirements to the existing power and heat assets and their operation. Furthermore, introducing large amounts of RE capacity will also challenge traditional power and heat infrastructure solutions when planning for the future energy system expansion.

Experiences from Salkhit Wind Farm

13. Wind, solar and run-off river hydropower plants are all driven by natural forces. Plants utilizing these resources are capable of regulating their production downwards but there is no possibility of increasing their momentary generation levels. Small hydropower generation can be forecast relatively accurately 24 hours ahead, but forecasting wind speeds and their directions, and cloudiness affecting ground level solar radiation, is substantially more uncertain.

14. In Mongolian context, it is important to realize that also the traditional power generation is highly dependent on natural forces, namely on outdoor temperatures. The P-100, PT-25 and P-12 turbines of the CHP plants are all of condensing-extraction type. The condensing end of the turbine makes it possible to produce electricity by the turbine independently from heat supply requirement. However, if heat demand is very high, most of the steam intake to the turbine must be let out for district heating purposes and less of the maximum steam intake is available for ‘independent’ condensing power generation. Therefore, the ‘regulating space’ of the turbine, and of the CHP plant as a whole, is dependent on outdoor temperature.

15. Overall power generation hence can be divided in the “must-run cogeneration” portion, which is directly proportional to the heat supply, and condensing power, which is not dependent on heat supply. It is of utmost importance to understand that the heat rate, i.e. the amount of coal consumed and consequently the marginal cost of electricity produced in these two modes is different. The cost of condensing power is in the order of three times more expensive that electricity produced in the co-generation mode.

16. The first wind farm in Mongolia at Salkhit was commissioned in June 2013. The nominal capacity of the wind farm is 49.6 MW and it is located at about 70 km distance from Ulaanbaatar. There are 31 GE wind turbines of 1.6 MW each. The first years of operation (from July 2013 to June 2014) indicated wind conditions equivalent to annual generation of 123 GWh and capacity factor of 28%. The average wind speed at the site is around 6.2 m/s with the maximum wind speed rarely exceeding 20 m/s. No strong seasonal pattern in wind speed was observed during the first year period except that wind speeds during summer months were generally lower than the annual average.

17. Limited operational experience of the wind farm from June 2013 to July 2014 indicated that 7.5 GWh of electrical energy was curtailed due to instructions from NDC. This represents 6 % of the power generation potential of the period. This figure is relatively high and raises a question about the reasons behind the wind curtailment. In the event there is a severe physical constraint in the system control, it forms potentially a severe impediment for increasing RE in Mongolia. Therefore, the root causes of curtailment need to be well understood, and from this understanding the consultant will propose solutions that allow higher RE penetration in the future.

18. As described above, the system operators have two tools available in Mongolia to control the supply to follow the load. One and the primary tool is CHP4. The second is the transmission connection to Russia. As the import/export line is dedicated for vital system control, frequency control and absorbing very rapid ramping needs, it can be assumed that day-to-day normal load follow-up should be the task of CHP4. *The key question is therefore why was CHP4 not capable of accommodating the variable supply from Salkhit wind farm during its first year of operation?*

19. Possible physical constraints can be divided in two categories as follows:

- Those related to turbine operations
- Those related to boiler operations

20. In both cases the instrumentation, control and automation systems also need to be up to the task.

21. In CHP4 all but one turbine are of the same type and all eight boilers are also of the same type. It can be assumed that any turbine can participate in load following, and the same should apply to the boilers unless there are unit-specific restrictions and differences related to staffing and instrumentation and control. It is furthermore understood that boilers of CHP4 feed steam to a common steam header whereby all boilers can participate in the load follow-up.

22. As to constraints related to the turbines, there are minimum and maximum load conditions. Apart from the turbine minimum load, there is a minimum steam that needs to be let to the condensing end of the turbine. Consequently, an extraction-condensing type of turbine produces some condensing power at all times in addition to the must-run cogeneration.

23. The turbine heat rate is typically not flat as a function of turbine loading but a curve that has a minimum point, normally at around 70% of turbine maximum load. Therefore, an optimal operating regime seeks that such number of turbines is in operation, which allows the turbines operate close or above to the optimum point. Operating at this point typically also leaves space for output increases and decreases. The turbine controllers can act within seconds and do not represent a constraint. The more turbines are in operation, the more there is space to absorb sudden changes in demand. Due to minimum load conditions, increases in wind power generation may lead to turbine shut downs, and vice versa, sudden decreases in wind output may result in the need to start a new turbine, which leads to steam load re-allocation of all other turbines as well. The operating practice related to this will be clarified during the mission.

24. If there is a situation that wind generation leads to turbine shut down, but the heat load stays unchanged, there is an opportunity in CHP4 to bypass the turbine via a pressure reduction valve, and continue feeding heat to the district heating system. In a modern power plant, this operation can be done almost instantaneously. Because the marginal cost of condensing power is much higher than cogeneration, it is reasonable first to reduce the condensing power of all turbines to the minimum, and only thereafter resort to by-pass a turbine.

25. The turbine starts and stops do cause extra wear in the turbines, but it is still considered as part of their normal operation. Therefore, avoidance of turbine starts and shut downs should not be a origin to wind generation curtailment.

26. The boilers of CHP4 are of the type BKZ-420-130-10C manufactured between 1983 and 1991 in Russia. They have a capacity 420 tons/h each. Their cold stars period can be estimated at around 5 to 6 hours, and the boiler can be considered cold after 10 hours from closure. The start/stop capability is approximately as follows:

- 1 hour closure – 1 hour start-up
- 3 hour closure – 2 hour start-up
- 6 hour closure – 3 hour start-up

27. When the boiler is hot the power ramping capability is 1.5 to 3% per minute. Boiler minimum load can be estimated at 30 to 40 % of the maximum and 40% minimum is assumed preliminarily in the following.

Testing the Minimum Load Hypothesis by Simulation

28. To understand the wind and solar curtailment needs, the Consultant has carried out preliminary simulations of CHP4 operations at various levels of wind and solar power input to CES. The following practical assumptions were made:

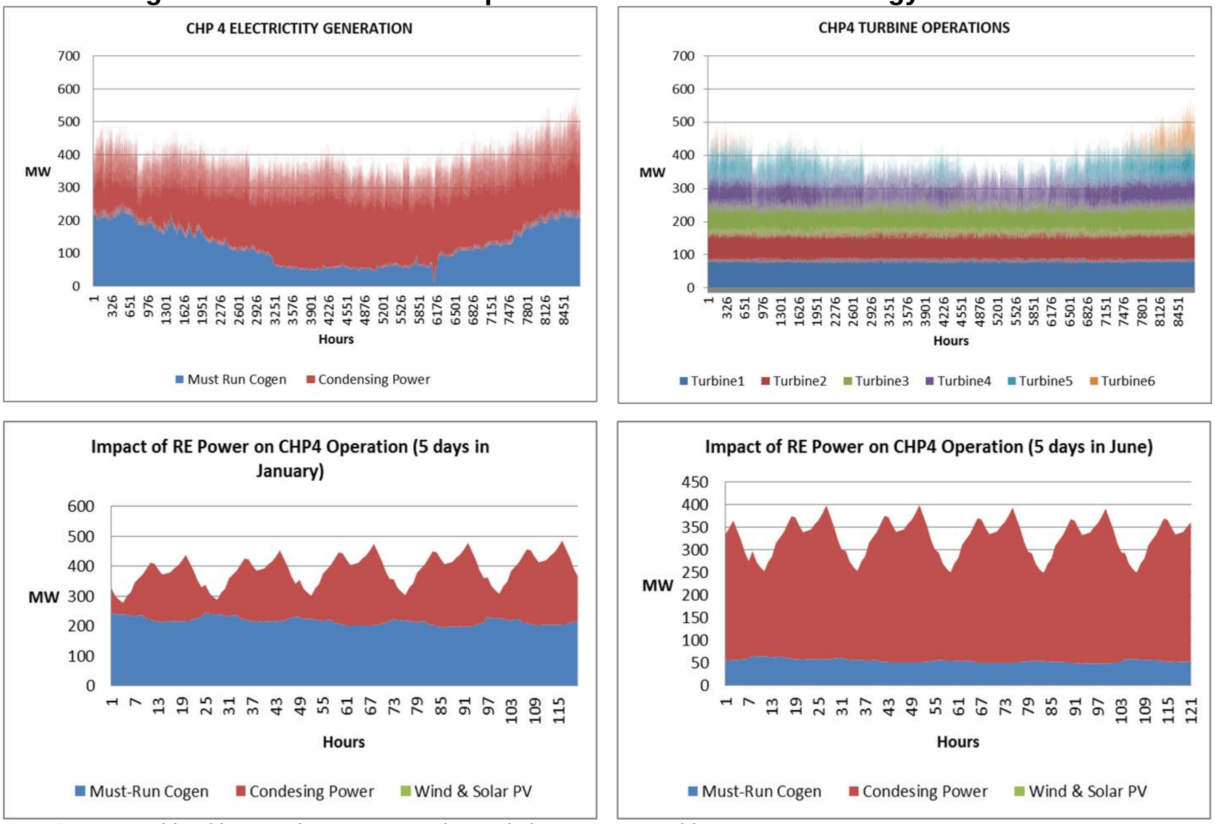
- The baseline data for CHP4 operation is based on actual daily generation data of 2011. Year 2011 is representative of a year, when there was not yet any wind power in the system and hence no boiler or turbine operations attributable to variable wind power output. However, these numbers are roughly adjusted to the situation of 2014 as to the average loading of the plant. This done by multiplying daily electricity outputs of 2011 by 1.16 representing the average growth of output from 2011 to 2014.
- Heat, wind and solar demands are not correlated with each other, because of lack of data. The heat demand is based on actual 2011 heat supply from CHP4 multiplied by 1.05 representing increased heat output of CHP5 from 2011 to 2014.
- Wind and solar data is based on MERRA data, which is a NASA reanalysis of the Goddard Earth Observing System Data Assimilation System Version 5 (GEOS-5). MERRA provides historical analyses on a broad range of weather and climate data in various locations. MERRA wind data represent wind speeds at 50 m height whereas some of the current wind farm measurements in Mongolia are based on turbine assumptions with higher hub height. Year 2014 data is selected for the analysis. Wind and solar data is then transformed to electric output of utility scale wind farms and solar PV fields using power curves of typical power plant configurations. The capacity factors were chosen conservatively at 26% and 14% for wind and solar PV energy respectively.
- Boiler minimum loads are set to 40 %. The maximum load is set at 90 %, which level then triggers need to start up a new boiler. Total load is spread evenly to all boilers which are in operation.
- Turbines have a minimum load of 15 % and minimum condensing power of 8 % of the maximum. Turbines are loaded evenly at every situation.

29. The logic of RE curtailment is set in the simulation as follows:-
    - Whenever the reduced plant’s load for high wind power generation calls for stopping one boiler unit, wind curtailment is triggered
    - However, if wind curtailment has continued over 8 hours, wind curtailment is ended and boiler will be shut or kept in operation depending on the situation of the hour. This condition simulates most occurrences of night time curtailment.
    - In the event the forecast for next 24 hours indicates need to shut down the boiler for a longer term, boiler will be shut and there is no curtailment.
    - In the event the reduced load for wind power generation calls for stopping two or more boilers, wind curtailment is triggered for as long as such situation continues.

Preliminary Simulation of Wind Curtailment

30. A baseline situation is demonstrated below assuming no wind in the system:

Figure D-1: Normal CHP4 Operation – No Renewable Energy Contribution



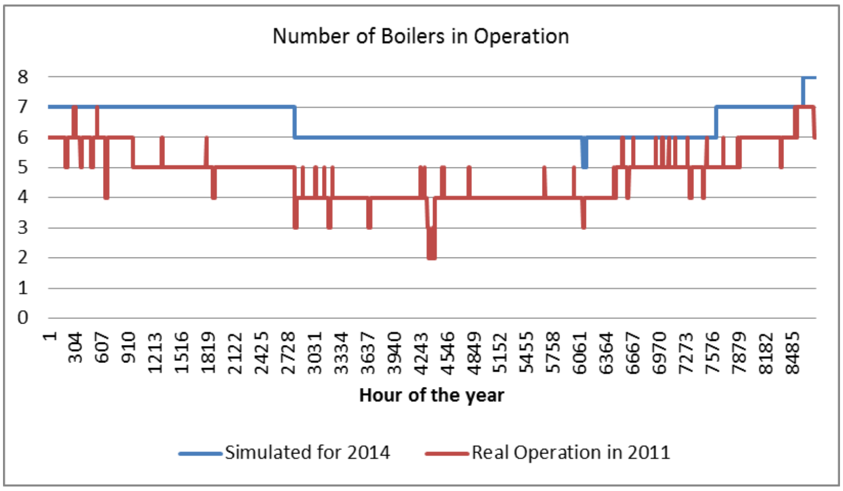
CHP = combined heat and power, PV = photovoltaic, RE = renewable energy.

31. One can observe how the loading is distributed differently between must-run cogeneration and condensing power in winter and summer seasons. The summer time electricity demand requires electricity generation in condensing mode, which calls for high boiler loading. Therefore CHP4 runs with relatively evenly through the year.

32. According to statistics, in 2014 there were 72 boiler stops, of which 22 were for emergency reasons and 50 were for normal operations. This equals to 100 normal boiler operations as there is a start for every stop. In 2011, according to operational statistics there were 90 boiler operations (i.e. 45 stops). Increased overall loading of the power plant will lead to less need for boiler operations. Given that in 2014 Salkhit wind farm has been in operation, yet the increase in boiler operations is not significant, it seems that the existence of wind power in the system has so far not resulted in major changes in the operational principles of CHP4. In practice, changes in wind output have not triggered boiler operations but in cases where boiler stop would have become necessary, wind curtailment has been enforced instead.

33. The simulation seeks the optimum use of boilers, which may not always be possible in real life operation. Therefore the baseline use of boilers in the simulation requires only few (7) boiler starts and stops as shown in the following graph, as compared with the around 100 that have taken place annually during the recent years. If 50 MW of wind is assumed, as is the case in 2014, the resulting number of boiler operations is 28. The following graph shows the simulated baseline boiler operations in 2014 without wind and the real operations of 2011. The increased loading of the plant is seen in the generally higher number of boilers in operation in 2014 compared to 2011.

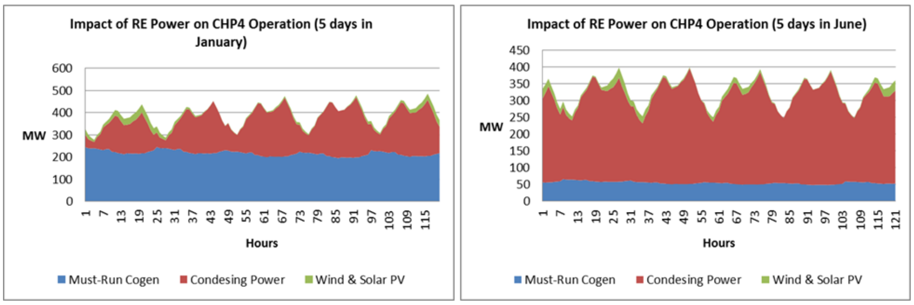
Figure D-2: Boiler Starts/Stops (no wind)



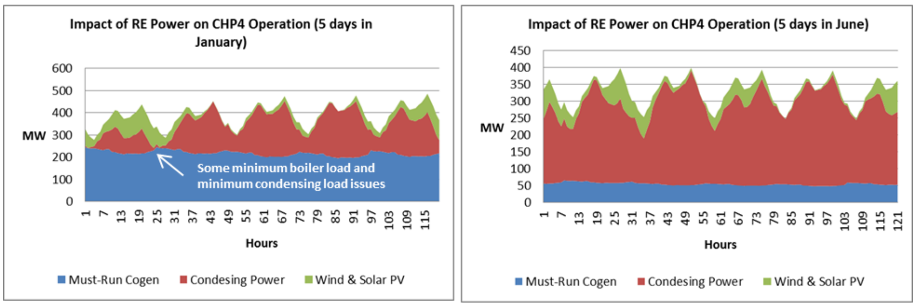
34. Figure D-3 demonstrates the changing loading of CHP4 with wind in the system.

Figure D-3: Wind and CHP4 Loading at Various Levels of Wind Penetration

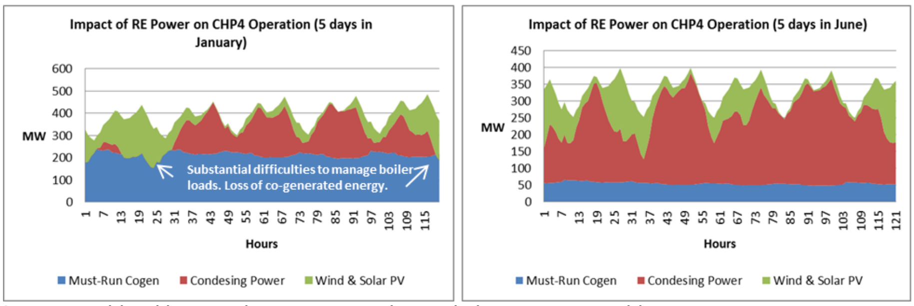
CASE: 50 MW WIND POWER



CASE: 150 MW WIND POWER



CASE: 300 MW WIND POWER

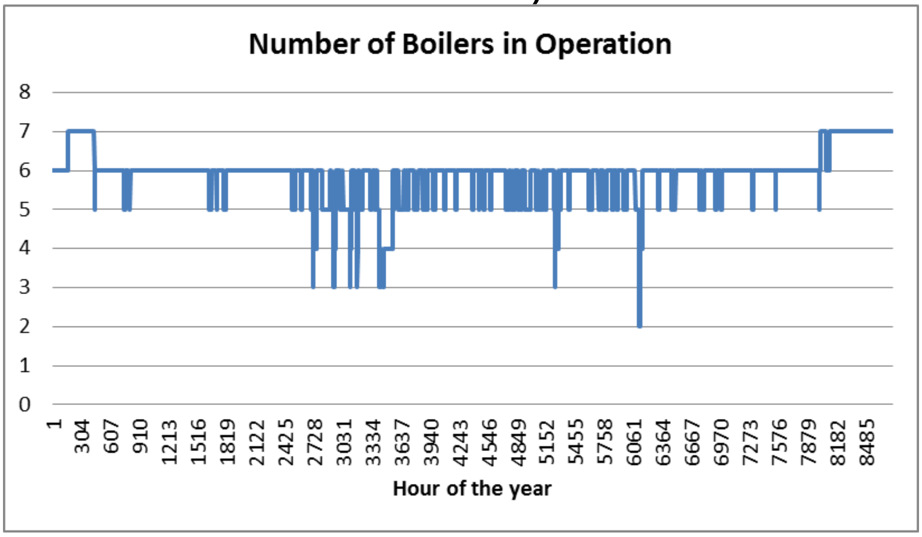


CHP = combined heat and power, PV = photovoltaic, RE = renewable energy.

35. An increase in wind generation causes increases in the need to regulate boiler operations in CHP4. According to simulation, 50 MW of wind energy in the system increases the annual number of boiler starts/stops from 7 to 28 when no curtailment is used. In 2014, with curtailment, the actual number was 100.

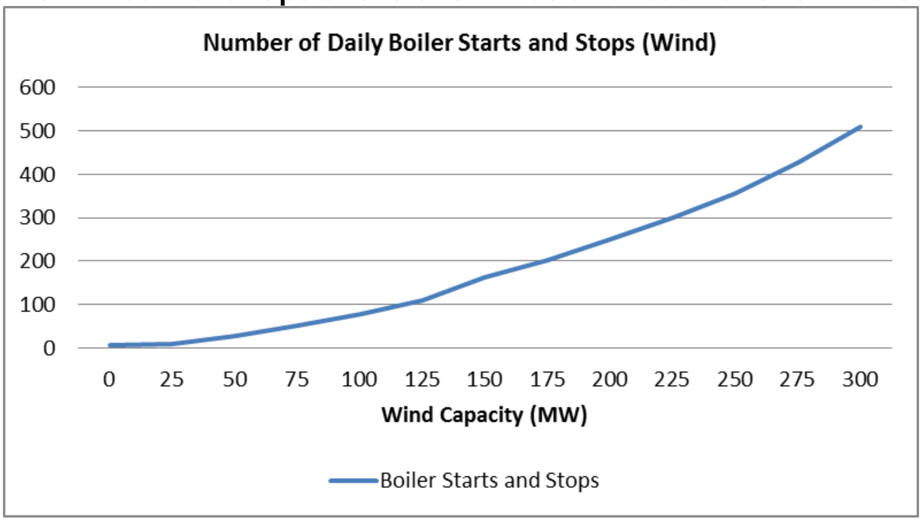
36. The following graph demonstrates the need to shut down and re-start boilers in the event the wind capacity is 150 MW. The resulting regulation need is 163 boiler operations (82 boiler stops) equal to 0.4 per day, and around 1700 turbine operations equal to 4.7 per day. These numbers are a practical possibility and can be executed if there are corresponding instructions from the National Dispatch Centre. The boiler stops in the simulation occur most frequently in Spring and Autumn. This corresponds well to the recorded starts and stops. Most frequently boiler stops/starts take place in March/April, July and November/December.

Figure D-4: Boiler Starts/Stops Assuming Wind Generation Capacity of 150 MW (without curtailment)



37. As mentioned above, the boiler operations are more critical for wind curtailment than the turbine operation. The number of boiler operations as a function of wind power entry is demonstrated in the following:

Figure D-5: Annual Boiler Operations of CHP4 as a Function of CES Wind Capacity

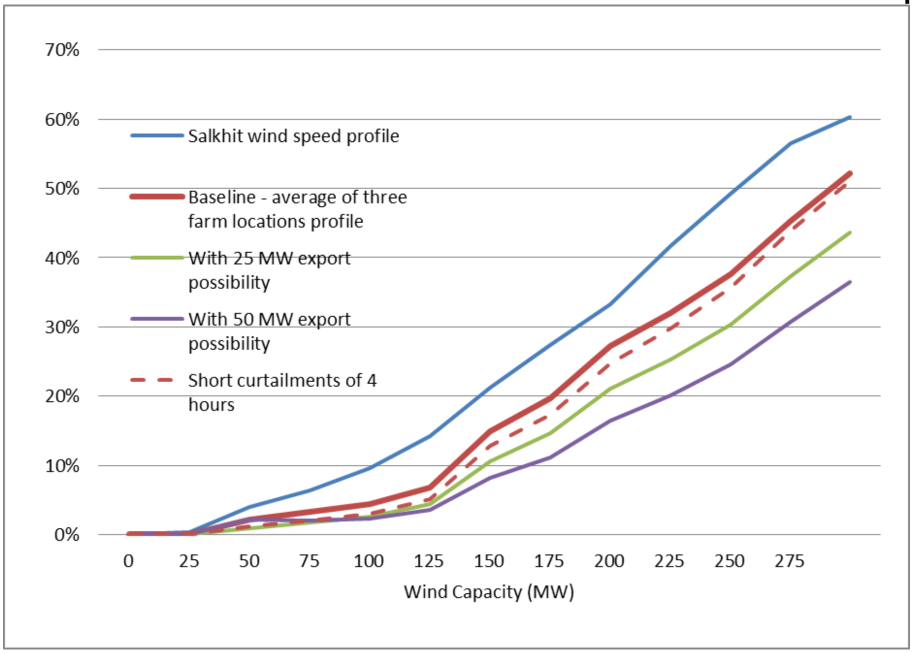


CES = Central Energy System, CHP = combined heat and power, MW = megawatt.

38. The boiler start/stop issue can be addressed by wind curtailment. If the operational rules of are applied, it will result in a more smooth operation of boilers, however, at the expense of losing

zero-marginal cost wind power and at the cost of coal based electricity. The resulting wind curtailment, assuming that CHP4 does not participate in the load following is demonstrated in the following graph.

Figure D-6: Simulated Maximum Wind Curtailment as a Function Wind Capacity



MW = megawatt.

39. The above graph also shows the impact of some variables. It shows what happens to wind curtailment (i) if having diverse locations for the wind capacity, (ii) if the simulation algorithm is changed in that the boiler stop will be triggered, in case during four hours there has not been a change in circumstances (instead of 8 hours as in the baseline), and (ii) the impact of the possibility to use export to Russia as a first buffer for a limited capacity, assumed here at 25 MW or 50 MW before initiating curtailment.

40. Assuming wind energy output of three locations, namely the average of Salkhit, Sainshand and Tsetsii, to which wind farms are planned, instead of the profile of only one farm, the wind profile will level out substantially leading to a more flat and predictable wind output. This consequently reduces curtailment substantially (by 50 % to 20 %) depending on the level of total wind capacity.

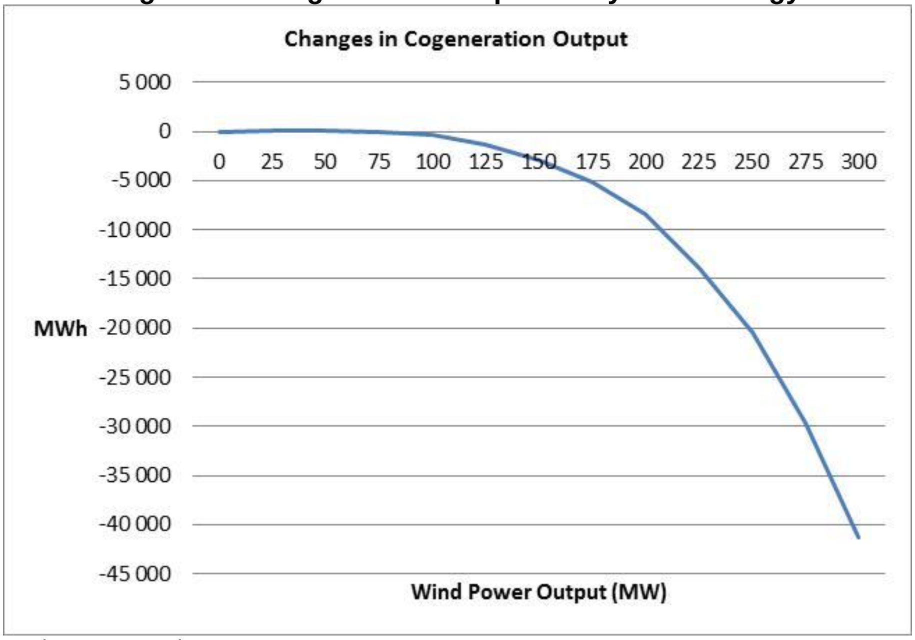
41. In the event the algorithm is changed, there is a minor reduction in overall wind curtailment (as night time curtailment is kept shorter). Testing the impact of 4 hours instead of 8 hours has importance in that short boiler stops, after which boiler is re-started from hot state, are substantially more economical than long boiler stops.

42. Finally, if there is a buffer, say possibility to export to Russia, which could be a topic of negotiation between the two system operators, say up to 25 or 50 MW of electricity, which would otherwise be curtailed, this would be of high value to the wind power operators. Economically, such an arrangement would be feasible to Mongolia at even very low export tariff rates, because the marginal cost of wind energy is negligible.

43. In the event one assumes an approach to keep wind curtailment at 25 % or less with the only load following facility being CHP4, it would result in the need of keeping wind capacity in CES below the level of approximately 175 to 200 MW.

44. Another issue, which is of economic nature, relates to the opportunity cost of wind power generation. The benefit of wind energy is higher when it replaces condensing power. However, when its amount in the grid increases, it replaces correspondingly more co-generated electricity which is of relatively low marginal cost. The effect is demonstrated below. However, now that the overall loading of CHP4 boilers has increased, and electricity consumption has grown at higher pace than heat demand, the share of condensing power has increased from the simulation results of the Inception Report. Consequently, the impact of wind power replacing must-run cogeneration is coming less in volume to the extent that such replacement does not have any substantial economic value to be considered by the planners.

Figure D-7: Cogeneration Replaced by Wind Energy

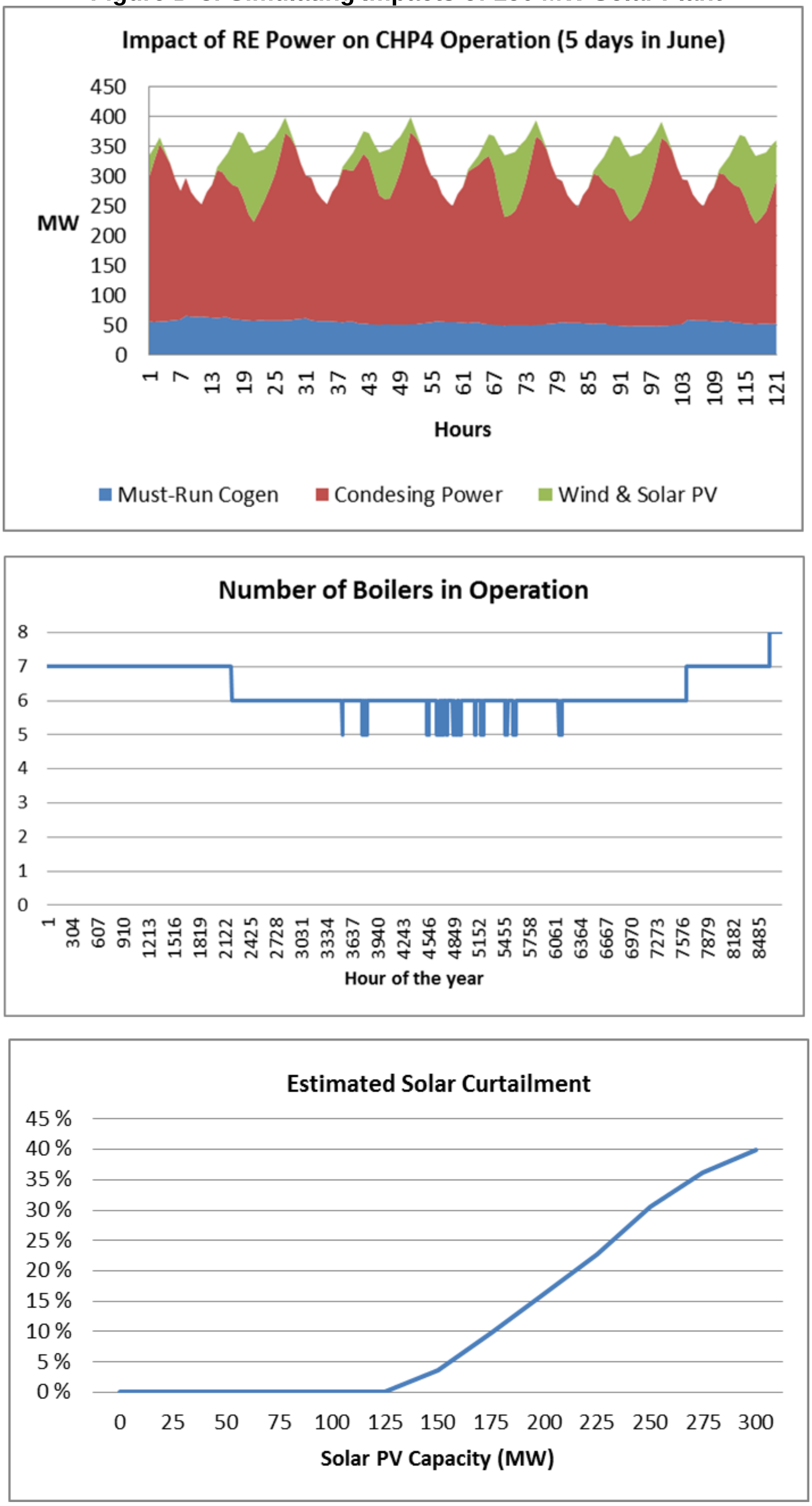


MWh = megawatt-hour.

Simulation of the Curtailment Needs Related to Solar Power

45. As to solar energy, the situation in the grid proves very different from wind energy. The main reason is that solar energy output occurs only during day time, and particularly at the time of the morning peak, when electricity is needed more than in the night. Because heat demand is temperature dependent and more thus constant over the 24 hours period, the higher daytime electricity demand must be covered by condensing power generation in CHP4. The simultaneity of solar PV with electricity business-hour peak is good so that PV capacities up to 75 to 100 MW in CES have a positive impact to the CHP4 boiler operations and help to even out the demand profile. Total impact of solar energy to the system operation is therefore not an issue to be concerned about.

Figure D-8: Simulating Impacts of 150 MW Solar Plant



CHP = combined heat and power, MW = megawatt, PV = photovoltaic.

Reviewing the Algorithm

46. To review the adequacy of the simulation algorithm, sensitivity of results to variations on key parameters were checked. Among the most critical parameters are the boiler minimum and maximum loads. The baseline numbers were 40 % and 90 % for the minimum and maximum load respectively. As boiler stop or wind curtailment is triggered when all boilers in operation reach the minimum load, this minimum is the most critical one.

47. The regulating ‘space’ of the facility is also constrained by its upper limit. The limit is less than 100 %, because there would not be any regulation space anymore at that point. A power plant, which participates in load following, cannot be run at such position. Furthermore, the technical condition and old age of the boilers may have caused that the 100 % loading is not always reachable.

48. As shown in Table D-2, wind curtailment logically decreases when regulating ‘space’ is increased by setting the minimum load lower and the maximum load higher than in the base case. The result is highly sensitive on the minimum load requirement. With 35 % minimum load, the resulting curtailment is less than half of that of the baseline.

49. The baseline, 40%, is considered a typical value for a Russian PC boiler. Having a lower minimum load may not be technically feasible, and it is believed that decades of operational experience has set the number in Mongolian plants to a well-tested and known level. Minimum boiler load is not only a technical and operational issue. Running a boiler at a very low load, results in incomplete combustion and thus in higher environmental pollution. Finally, it should be noted that the simulation model does not image CHP4 perfectly, as its purpose is to demonstrate the phenomenon of curtailment rather than to provide completely accurate numbers. The results should not be interpreted as exact forecasts or targets for curtailment in different situations.

Table D-2: Estimating the impact of boiler minimum and maximum loads

WIND CURTAILMENT AS FUNCTION OF BOILER LOAD LIMITS				
Wind Capacity	50 MW	100 MW	150 MW	200 MW
Baseline	2.2 %	4.3 %	14.9 %	27.2 %
Min. Load				
35 %	0.0 %	2.2 %	4.7 %	14.1 %
45 %	9.6 %	12.6 %	24.6 %	35.1 %
Max Load				
85 %	2.3 %	5.4 %	13.9 %	26.4 %
95 %	1.3 %	2.9 %	16.5 %	29.4 %

MW = megawatt.

50. Curtailment is less sensitive to the upper limit, and the respective results can de facto be ignored because reaching the upper limit does not trigger wind curtailment. The upper limit cannot be very low (80% or less), because CHP4 would then not be able to serve its designed peak load.
51. The Consultant has carried out preliminary simulations on the RE curtailment assuming that CHP4 is the main vehicle to carry out load following in CES of Mongolia. The results of the simulations can be summarized as follows:

1. CHP4 has not been designed to carry out intensive load follow-up, but is able to do it with limited capacity of variable RE supply in the system. It is estimated that the boiler operations of CHP4 can absorb wind power capacity in CES up to 125-175 MW. More exact guidance on technically possible wind capacity level requires the Consultant refines the simulation and checks assumptions with NDC and CHP4 operational management during next mission to Mongolia.
2. The operating practices and wind curtailment guidance policy to CHP4 by NDC need to be reviewed but on basis of preliminary analysis they seem to be in line with the assumed technical capabilities of BKZ-420 boilers of CHP4.
3. Solar energy is conducive from the system regulation point of view. Higher levels of solar energy feed to CES help to reduce boiler starts/stops during Spring, Summer and Autumn periods. Up to 250 MW of solar power can be accommodated without major impacts on system regulation.

Some Financial Aspects of Load Follow-up and Curtailment

52. The marginal cost of CHP4 electricity generation can be roughly estimated at 22 $/MWh. This is based on estimated fuel cost of 4.5 US$/MWh$_{fuel}$ at coal cost of 17 US$/ton and LHV of 13.5 MJ/kg, efficiency rate of 27% in condensing mode, and other variable cost of 5 US$/MWh$_{e}$. This estimate is without consideration of external costs of coal combustion such as cost of pollution and consequent health effects or cost of emitted CO_2. Furthermore, the cost is also exclusive of subsidies that may be included in some operating cost items of CHP plants in Mongolia. Several state-owned entities supplying materials, water and coal do not operate on fully financially sustainable grounds but enjoy government subsidies which offset operational losses at the end of the year.

53. A boiler start from cold state requires about 25 tons of mazut, at cost of around 14,000 US$ per start whereas starting from hot state may require about 16 tons of mazut at cost of about 9,000 US$ per start.

54. The export/import tariffs are not known to the Consultant, but it is estimated here that unscheduled export is compensated at 14 US$/MWh (28 MNT/kWh). Marginal fuel cost of wind energy is zero. Non-fuel variable cost can be estimated at 5 US$/MWh.

55. The benefit of replacing condensing power by wind energy is therefore 17 US$/MWh (22 US$/MWh – 5 US$/MWh).It is therefore clear that in normal operation it is always feasible to dispatch wind energy before CHP4 or other coal based power stations. However, it is rational to curtail wind power to avoid a boiler start from cold state in the event the curtailed energy is less than 825 MWh (14,000 US$ / 17 US$/MWh); and from hot state, if the curtailed energy is less than 529 MWh. Therefore, one can conclude that in most cases with the current installed wind capacity of 50 MW, these criteria are not fulfilled and it is reasonable to avoid boiler stops. The breakeven periods for curtailment are 33 hours and 21 hours, for cold and hot start respectively.

56. Because the sales revenue of unscheduled export to Russia are higher than the marginal cost of wind energy, it would be feasible to export excessive energy in the system to Russia at times when CHP4 is not able to balance supply to demand without incurring higher cost due to boiler stops. However, it is reported that Russian system operator allows no unscheduled import from Mongolia, and that unscheduled deliveries may result in Russia disconnecting temporarily the connecting transmission line. Mongolia in therefore encouraged to seek more favourable terms for

electricity exports considering the new situation in her system with increasing RE based electricity generation.

57. CHP4 has the role of running in the load following mode and keep the import/export schedule with Russia. It is, however, not completely clear to the Consultant, to which extent unscheduled wind supply, which is in excess of the forecast amount, is currently absorbed by load following actions of CHP4, and to which extents such supply is forwarded to Russia as unscheduled export. Overall, the exports to Russia have been in the range of 20 to 23 GWh annually, and in 2014, when Salkhit farm was in operation, it was around 30 GWh.

58. The current dispatching practice does not provide financial incentives for CHP4 to perform load following over and above the target of meeting the import/export schedule, vice versa:-

- The generators have to pay penalties for deviations from day-ahead forecast generation
- Any adjustment downwards of power generation to accommodate increased supply of intermittent wind energy will result in lost sales revenues for CHP4
- Stopping a boiler in CHP4 for increased wind energy supply will result not only in lost sales revenue but also in additional costs for boiler start-up

59. Because there is a government backed goal of promoting wind and solar energy supply in Mongolia, new mechanism for the Single Buyer should be developed to accommodate more intermittent energy to the system. One option would be to classify CHP4, or some units of it, as a load following entity, which is entitled for compensation for cost-incurring actions as a response to varying wind output. It could be to change its electricity sales tariff from flat average tariff to two component tariff, which included capacity payment for such capacity portion of the plant, which operates in load following mode for wind, whereby a momentary reduction in its output would not impact its annual revenue level, and a variable payment to cover variable cost of electricity generation. The second option is that individual load following actions are compensated according to a pre-agreed schedule as far as those actions are instructed by National Dispatch Centre.

Potential Solutions to Accommodate More RE to the System

60. Technical Assistance Report for Mongolian National Dispatch Center (33389-012) issued by PRDC Pty Ltd and financed by Asian Development Bank listed a number of short and medium term strategies to address the system operation challenges caused by wind integration, as follows:-

- Improvements to wind forecasting and forecast accuracy by rolling updates to 24-hour ahead generation forecasts
- Amendments to market rules aiming at better forecast accuracy
- Interconnecting EES and WES to CES to increase balancing area
- Increase electricity demand during night through tariff incentives for electricity-to-heat projects and in general promote power to heat technologies
- Promote electric vehicles in Ulaanbaatar city
- Refurbish CHP2, CHP3, Darkhan and Erdenet power plants for adding flexibility to CES
- Implement storage in order to reduce electricity import from and export to Russia
- Develop hydro resources including pumped hydro storage
- Develop export market for electricity

61. This study has identified the physical constraints of CHP4 as the main cause of the curtailment issue. In addition, there are commercial and attitudinal issues due to which there is only limited interest among power generators and regulators to effectively work for reducing wind curtailment. With these observations the suggested measures above do not appear topical and effective. For example, the refurbishment of CHP2, CHP3, Darkhan and Erdenet are considered having only marginal value given that the country aims at enabling RE capacities in hundreds of megawatts. The feasibility and potential of electricity-to-heat technologies to reduce wind curtailment have not been proven. Some of the measures can be implemented only during a very long time period.

62. The Consultant considers the following technologies and solutions suitable to be developed as part of ever expanding wind and solar power capacity in Mongolia:-

- Heat pump technology
- Heat storages (combined with the above two)
- Wide geographic dispersion of RE assets

63. Many of the listed measures have often been mentioned as prospective for Mongolia. Few studies, however, analyse their merits on economic grounds or aim at a critical analysis of the associated technical challenges. It is known, for example, that air-to-air heat pumps do not operate well during such big freezes that are common in Mongolia. Therefore, identification of prospective low temperature heat sources for heat pumps is essential. Such heat sources may be associated with waste water treatment facilities or power plant or boiler flue gases. Further, the geology in and around major population centres needs to be reviewed, to conclude whether or not heat pumps in these cities can use ground rock as heat source. Combining heat pumps with geothermal energy would provide an excellent fit for wind energy with both source heat and driver energy being renewable by nature. However, again, the nearness of geothermal sources to major population centres needs to be clarified.

64. In the medium and long terms, the following planned investment will likely reduce or eliminate the wind curtailment issue:-

- Construction of CHP5, or any other large scale new coal fired plant, such as one planned for Baganuur, will add more large boilers and turbines to the system, which will allow more ‘regulating space’ and enable more effective load following
- Any of the planned large-scale hydropower plant, Egiin or Shuren, would enable balancing supply and demand in Mongolia’s Central Electricity System.
- In the event none of the above materializes, Mongolia could also consider constructing a modern mazut-fired power plant based on reciprocating engines, which employ a series of techniques and features that allow them to offer excellent simple-cycle efficiency designed specifically for fast load following capability to enable increasing the amount of variable renewable generation.

65. Meanwhile, a review of current rules, regulations and practices as to exports to Russia, economic dispatch of generation, and financial incentives offered for load balancing and ancillary services, should be carried out, and new and innovative solutions offered to solve the emerging RE curtailment issue in Mongolia.

ANNEX E. ASSUMPTIONS USED IN ESTIMATING LEVELISED ENERGY COSTS

Cost of Renewable Energy in Mongolia

1. During recent years, the costs of wind and solar PV energy installations have continued to fall. At the same time the performance of both technologies has improved. Investor confidence has increased worldwide to the extent that today wind and solar PV can be regarded as ordinary technology choices for many large power utility companies. This all means that also the perceived risk associated with these technologies has reduced which reflects positively to the investors' return requirements on renewable energy projects.

2. There has, however, not been many RE investments in Mongolia yet. The most important was the Salkhit 49.6 MW wind farm commissioned in June 2013. There are other projects in the pipeline, such as another project of Clean Energy LLC of 150 MW, Choir Wind Farm project of 50 MW, and Oyu Tolgoi Wind Farm project of 250 MW. On the solar front, there is the National Renewable Energy Center developing a 440 kW solar PV project at the Chinggis Khan airport. The number of projects is still relatively small so that one cannot say there would be accumulated engineering experience of RE facilities in Mongolia, which would increase confidence in their financial and technical performance under the specific regulatory environment and the climatic conditions of the country.

3. Given the FiT policy quoted above, and the estimated RE technology costs a short preliminary review of the adequacy of prevailing FiT levels is given in the following. The grid connection costs and costs associated with mitigating the intermittency of electricity supply is ignored as this stage, but will be discussed in the later stages of the study. The review draws from international cost experience mainly from three sources. One is the updated cost report of International Renewable Energy Agency (IRENA) of 2014. The second is Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants of the US Energy Information Administration issued in April 2013. The third is a large survey of the costs of Utility Scale Solar 2012 by Lawrence Berkeley National Laboratory.

Weighted Average Cost of Capital

4. A critical parameter in estimating costs of different energy technologies is the weighted average cost of capital (WACC). The WACC has been calculated according to the following standard formula:

$$WACC = \frac{E}{D+E} * Ce + \frac{D}{D+E} * Cd * (1 - Tc)$$

, where

- E/(D+E) is the share of equity in total financing,
- D/(D+E) is the share of debt in total financing,
- Ce is cost of equity,
- Cd is cost of debt,
- Tc is income tax rate

5. It is assumed that financing would consist of 30% equity, and 70% debt funding. Assuming many of the RE investments in Mongolia are financed by foreign investments and to avoid uncertainty related to the local inflation and foreign exchange rates, project valuations in the following are carried out in US$, and thus WACC estimate is also done for equity and loan financing in US$. US$ inflation is assumed at 1.5% per annum.

6. Tax rate in Mongolia depends on taxable income value. Taxable income up to 3 billion MNT is taxed at 10%, the excess over this sum is taxed at 25%. For the evaluation purposes, 25% is used as corporate income tax rate.

7. Annual cost of debt issued in US$ can be divided in three categories. One category consists of local project developers, who can draw US$ denominated loans from local banks. The interest rate can be assumed to be 14%. This estimate is based on publicly available rates for loans nominated in US$ which are provided by Mongolian commercial banks for investment and project financing, as well as for corporate credit lines. Bearing in mind that the current refinancing rate set by the Bank Of Mongolia for MNT loans is 13%, one can notice that local commercial loans issued in US$ are relatively expensive (and usually are given for no longer than 3 years).

8. The second category of RE project lenders are foreign investors, whose interest can assumed to be mostly in relatively large developments backed up by the government through appropriate PPAs. These companies would seek lending from foreign banks outside Mongolia. One could therefore take a reference of the bond markets from debt issued at similar rating as Mongolia (Moody's current rating is B2, S&P B+). Yield on Mongolian Government's international 10 year bonds nominated in US$ is used as an underlying best rate for further estimate. These bonds were issued in November 2012 and are due in December 2022. The initial yield was 5.125% and according to the latest available data from the Stuttgart Stock Exchange, these bonds' yield is currently 7.93% but its trading is thin. In this context, one can assume cost of debt of around 10% for private companies' energy infrastructure projects in Mongolia.

9. The third category is lending by international financing agencies, such as Asian Development Bank and the World Bank. We assume for the case of simplicity 3.5 % cost for such debt.

10. Private investor's risk perception is also dependent on the lending parties. If and when there are international agencies involved, their thorough project preparation and analysis provides security to the equity parties. Furthermore, involvement of international agencies in the project results in reduced perceived risk on regulation and government policy. In this context, in the first two cases the equity investor's return requirement is estimated at 16% whereas in the third cases having public entities directly involved, at 12%.

11. With these estimates, WACC for the three project profiles can be set as follows:-

Table E-1: Weighted Cost of Capital Estimates for Mongolia

Real Terms	Locally financed USD debt			Foreign Investment			Concessional Lending		
Item	Loan	Equity	*Sum*	Loan	Equity	*Sum*	Loan	Equity	*Sum*
Amount	0.7	0.3	1	0.7	0.3	1	0.7	0.3	1
Weighting	70 %	30 %	100 %	70 %	30 %	100 %	70 %	30 %	100 %
Nominal Cost	14.00 %	16.00 %		10.00 %	16.00 %		3.50 %	12.00 %	
Tax Rate	25 %	0 %		25 %	0 %		25 %	0 %	
Tax-Adjusted Nominal Rate	10.50 %	16.00 %		7.50 %	16.00 %		2.63 %	12.00 %	
Inflation Rate	1.5 %	1.5 %		1.5 %	1.5 %		1.5 %	1.5 %	
Real Cost	8.867 %	14.286 %		5.911 %	14.286 %		1.108 %	10.345 %	
Weighted Component of WACC	6.207 %	4.286 %	**10.493 %**	4.138 %	4.286 %	**8.424 %**	0.776 %	3.103 %	**3.879 %**

WACC = weighted cost of capital.

12. For simplicity, WACC of 10% is used in the following; and in the analysis of large projects, which might be of interest to development financing institutes and the government, the impact of WACC of 4% will also be tested.

LCOE of Relevant Energy Technologies

13. Wind power technology has seen a tremendous development over the last five years with current worldwide installed capacity exceeding 360 GW. Wind turbine prices have fallen by around 30 % in five years, China having been the major engine in this development as investor in wind energy and manufacturer of wind turbine technology.

14. The weighted international average of installed costs for onshore wind range from US$ 1,280 to 2,290. Therefore, there has been some decrease in the equipment cost of wind power since the Salkhit project. Still, due to the experience of large scale wind being limited to one project, the local learning curve may not be enough to guarantee costs at average or below average level for Mongolia. The harsh climatic conditions and long transport distances also add to the capital costs.

15. The following assumptions are taken for large scale wind power in Mongolia (2015):

- Installed cost of 2000 US$/kW
- Capacity factor of 36 %
- Fixed O&M cost of 1.5 % of installed cost
- Variable O&M cost of 5 US$/MWh
- Capital expenditure period of 2 years and life of plant of 25 years

16. Solar PV technology has witnessed probably the highest cost decrease of all energy technologies. The PV module prices reduced approximately 75% in five years. The PV technology in utility-level applications can be classified roughly by two important technical parameters. One is whether the project uses crystalline-silicon (c-SI) modules or amorphous Si thin film modules. The second dimension is whether or not the modules are mounted at a fixed-tilt or on a tracking system.

17. Due to mass production and fierce competition typical residential PV systems based on crystalline-silicon (c-SI) modules challenge well the amorphous Si thin film modules, which used to be more common and economical in earlier utility scale applications from 2005 to 2010. The system costs have since then converged.

18. As to having the tracking system in the plant, it represents an additional cost but provides a higher energy yield. One-axis tracking, although it increases capital costs by 10% to 20%, can be economically attractive because of the increase in energy-production (20% to 30% more kWh/kW/year in areas with a good solar resource).

19. The Lawrence Berkeley National Laboratory study gathered cost and price data for 202 utility-scale (i.e. ground-mounted and larger than 2 MW) solar projects in the USA totalling more than 1,735 MWAC, of which 194, representing 1,544 MWAC, consisted of PV projects. Important observations were made on recent cost trends. The clear convergence in the average price of c-Si and thin-film projects was observed. The development is due to declined price of silicon combined with global excess of c-Si module manufacturing capacity. The economies of scale appear to diminish considerably when the system capacity goes beyond 5-10 MW. Overall, the system prices had fallen from around 5,600 US$/kW of the period of 2007-2009 to 3,900 US$/kWh on average for projects completed in 2012. Anecdotal evidence was given about cost reductions continuing to 2013-2014 to the extent that a large US project had reported an installed price of 2,030 US$/kW to the regulator. IRENA reports the solar PV costs at between 1,570 and 4,340 US$/kW, but also that the utility scale systems average at around 2,000 US$/kW. According to IRENA, the 2,000 US$/kW level has remained relatively flat for the utility scale system from 2012 to 2014.

20. According to IRENA, the weighted average of capacity factor for utility scale projects in Asia, outside of China and India, is around 14%. In China the average capacity factor is around 17%. The capacity factor is highly dependent on selected technology (especially on the tracking system) and the site conditions (cloudiness, dust etc.). With the above references, the average factor for Mongolia is set here preliminarily at 15%, but this assumption will later be reviewed with the National Renewable Energy Center (NREC).

21. The operation and maintenance (O&M) costs reported in the USA appear to be in the range of 20 to 40 $/kWAC,a, or 10-20 $/MWh. These represent approximately 0.5 % to 1 % of the installed capital cost annually. The O&M costs are related to module cleaning, panel repairs and replacements, vegetation control, maintenance of mounting structures, and maintenance of the power system covering inverters, transformers, switchgear, internal wiring and grid connection. Part of the maintenance is labour intensive and therefore lower costs can be assumed in Mongolia than the US reference.

22. Realizing there is a large project-dependent cost variance, we assume the following for Mongolian utility scale PV installations (in the range of 10 MW) in 2015:

- Installed cost of 2200 US$/kW
- Capacity factor of 15%
- O&M cost of 0.9 % of the installed cost
- Capital expenditure period of 1 year and life of plant of 25 years

23. Concentrating Solar Technology (CSP) is an emerging RE technology developed strongly in Spain, the USA, in the Middle East, South Africa and elsewhere, where solar irradiation levels are good. The solar CSP market is dominated by parabolic trough technology, which represents approximately 85% of the worldwide installations. However, interest in solar tower technology is increasing, and the most notable CSP project in the world, the Ivanpah Solar Electric Generating System in South California USA, embodies this technology. The plant has three solar thermal plants with total gross capacity of 392 MW.

24. The solar irradiation levels in Mongolia are on average between 1350-1850 kWh/m^2. Annual irradiation in Ulaanbaatar is above 1800 kWh/m^2 and the highest levels are achieved in Southern Mongolia, in Gobi area to around 2000-2100 kWh/m^2. The irradiation levels are not typical for CSP plants, which are still relatively expensive and are built to the very best locations to maximize plant efficiency. Despite this fact, the approximate costs are presented here for reference. It is believed that it is worth of analyzing whether or not CSP technology could be adapted to local conditions by integrating it to the district heating systems.

25. There are some other barriers too in Mongolia that impact the feasibility of a typical parabolic trough CSP installation. Cold weather causes need for additional heating during night times to keep the heat transfer fluid and heat storage at right temperature. Lack of water causes the need to have dry-cooling technology for condensing, which causes slightly lower cycle efficiency of the power block. Finally, a typical CSP plant uses natural gas to smoothen the electricity output and to increase the plant efficiency. Natural gas is not available in Mongolia, and its nearest alternative light fuel oil is very expensive and difficult to transport to the typically remote sites of CSP plants.

26. IRENA reports the installed costs to range from 3,550 to 8,760 US$/kW in 2013 and 2014. The wide range comes from projects implemented in highly different environments and countries, and especially for the variation in plant technologies with and without energy storage and the amount of storage.

27. As for reference the following characteristic are used in the cost estimate for a parabolic trough plant of 50 MW with a relatively large storage:

- Location in South Gobi
- DNI 2100 kWh/m^2, a
- Capacity 50 MW
- Turbine cycle efficiency of 37.5 %, auxiliary use of 10 %
- Annual net generation of 177,000 MWh
- Air-cooled dry condenser
- Solar collector field area of 621 000 m^2
- Heat storage capacity of 1000 MWh
- Support fuel: oil
- Annual electricity generation of
- Installed cost of 8,250 US$/kW
- Fixed operating cost of 1.2 % of CAPEX
- Variable operating cost (including mazut) of 46 US$/MWh

28. Hydropower is an important potential in Mongolia, which is yet to be utilized. The introduction of wind and solar energy to the system will bring the need to have more such capacity, which is capable of load follow up and fast ramping, and hydropower can meet many of these needs. In

terms of megawatts, hydropower may not be the largest renewable energy source for Mongolia, because the rivers potential for construction in Mongolia are not so many and many sites are environmentally sensitive, but in terms of positive effects to the system and ability to act as enabler for more wind power it would have an important role.

29. Hydropower is mature technology, but in Mongolian context the costs of constructing some of the identified sites remains rather difficult to assess. There are engineering studies of only few sites, and some recent feasibility analysis of Shuren, Egiin and Orkhon. Studies and reports have indicated capital costs from 1,300 US$/kW to 1,600 US$/kW, and load factors of 40%, 25% and 25% for Sheuren, Egiin and Orkhon respectively.

30. References for typical small hydro power plants can be found from the CDM documentation of Taishir 11 MW and Durgun 12 MW plants, which were built in 2011 and 2008 respectively, and from the feasibility study of Chargait 24.6 MW small hydropower plant.

31. On basis of the limited references and cost analysis carried out in the ADB Energy Masterplan Study for Mongolia (2012), installed costs of hydropower are assumed here roughly as a range from 2,000 US$/kW to 4,000 US$/kWh, the lower level representing best sites for large scale hydro and the higher level representing typical small scale hydro. The capacity factors of hydropower plants are highly site dependent, and can be influenced by the specific engineering solutions selected for the site. Therefore, capacity factors are shown in the following to span from around 25% to 40%, which is considered typical in Mongolia. The variable O&M cost is assumed at 2 US$/MWh, and the fixed O&M cost at 1 % of the installed cost for large scale hydro and 2 % for small hydro power.

32. The geothermal energy is left out from this preliminary analysis as its applicability for electricity generation in Mongolia is still highly uncertain.

33. The above typical costs are referenced against the cost of coal fired power generation in a hypothetical 3x150 MW condensing power plant with subcritical pulverized coal combustion technology but equipped with state-of-the art flue gas cleaning for particles, sulfur and nitrogen oxides (NOx). The reference plant has the following characteristics:

- Installed cost of 2000 US$/kW
- Net efficiency of 34%
- Capacity factor of 70%
- Fixed O&M cost of 2.0% of installed cost
- Variable O&M cost of 3.2 US$/MWh
- Coal cost of 15 US$/ton and LHV of 13.5 MJ/kg (lignite)
- Capital expenditure period of 4 years and life of plant of 25 years

The technology costs specified above are used to calculate the Levelized Cost of Energy (LCOE) at the given typical capacity factor as presented in the main report. LCOE calculation assumes that the present value of the sum of discounted revenues of a plant is equal to the present value of discounted costs. LCOE thus represents the break-even value for the average energy cost that an investor can shoulder with the given weighted cost of capital (WACC) and other preconditions. The revenues are represented in the calculation by the discounted flow of outputs, namely electricity (MWh). The calculation is based on a cash flow on annual basis.

ANNEX F. CO-BENEFITS

1. This Annex provides a list of co-benefits that are expected from the implementation of SREP investments.

Annex Table F-1: Co-Benefits Associated with SREP Impacts and Outcomes

Results	Co-benefits	Description
Support low-carbon development pathways by increasing energy security	Avoided GHG emissions	SREP investments will improve energy security and reduced dependence on imported fossil fuels. It will provide clean and reliable energy sources, and will reduce GHG emissions from the avoided use of fossil fuels. An estimated 32,000 tCO2e/year by 2020 will be avoided from the implementation of the projects. The capacity building TA could potentially facilitate development of hundreds of megawatts on new RE capacity with huge reducing impact on CO_2 emissions from coal based power generation.
	Employment opportunities	SREP funding will support job creation and skills development related to the construction/installation, operation and maintenance of renewable technologies. The employment opportunity will extend to the remote Western Region of the country, which is lagging behind in economic development and income as compared to the country's average. Education of the workforce in the deployment of these technologies will be a feature of the Western Energy System RE project. Each project also offers possible opportunities for targeted job creation for women (for example, requirements that the plant operators provide earmarked jobs for women. Mongolia has a generally good track record in allowing and promoting women's career development. It will encourage private sector participation and create new economic activities and jobs related to these renewable energy technologies.
Increased supply of renewable energy	Increased reliability	The establishment of RE sources of 25 MW (20 MW solar PV, 5 MW wind) in the Western Energy System could contribute to obtaining around 19% of electricity to the region from the new RE plants which demand are typically met by imports from Russia and other conventional fuels sources. It will increase energy securot The solar PV will generate electricity during high-demand daytime periods and will similarly enhance supply adequacy and reliability during the hours of the day in which the value of lost load and losses are typically the highest. Wind energy will supplement the supply. The small hydropower plant will replace part of imports from China to three southern soums. Women will equally benefit from better security and reliability of supply. It is will reduce their time from collecting woods and other biomass for fuel use.
New and additional resources for renewable energy	Reduced cost of RE	SREP investments will facilitate the reduction of electricity imports and will promote higher level of energy independence.

Results	Co-benefits	Description
projects/programme		The country lacks indigenous natural gas resources, and is landlocked; not only can it be expected that the cost of importing gas will be high but high dependence on neighboring countries for gas supply involves fuel supply risks that may be very costly to mitigate.

GHG = greenhouse gas, MW = megawatt, PV = photovoltaic, RE = renewable energy, SREP = Scaling-up Renewable Energy for low-income countries Program, TA = technical assistance, tCO_2e = tons carbon dioxide equivalence.

ANNEX G. PROJECT CONCEPT NOTES

Component 1 – Upscaling Rural Renewable Energy

1. Background

1. In meetings with GoM, Ministry of Energy (MoE) officials opted for renewable energy system development in small cities and towns in the Western Region of Mongolia as a priority investment for SREP funding support. MoE highlighted that the Western Region has witnessed a 15% of annual

load demand increase for last 5 years but relies heavily upon diesel power generation and electricity imports from Russia to meet such load demand. MOE purports to build demonstration project for renewable energy system (solar, wind, and shallow ground heat pump) deployment in targeted cities and towns in the region to decarbonize local energy system and minimize electricity import from Russia.

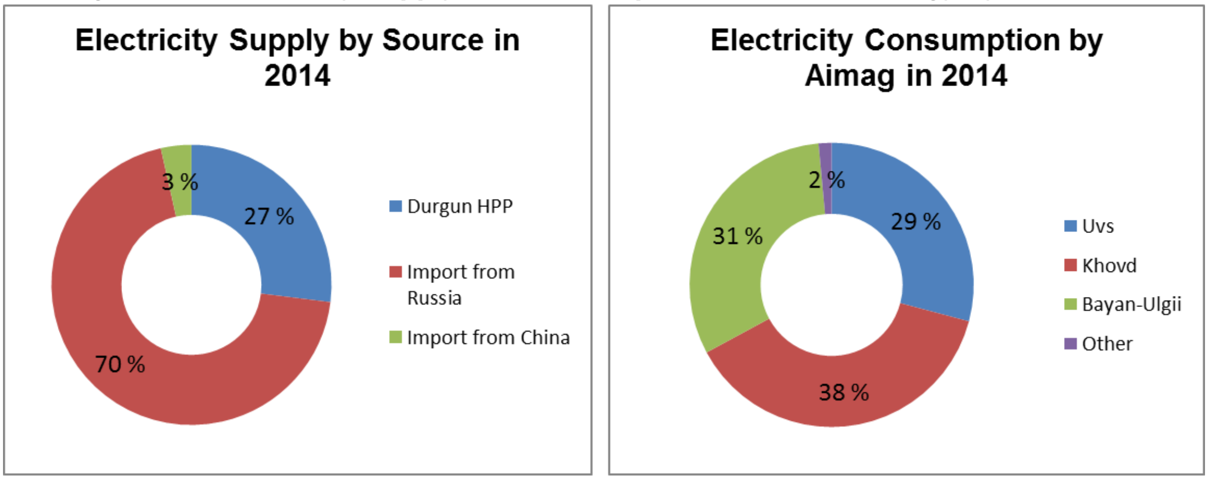
2. Western region is composed of three provinces (aimags) of Mongolia, Uvs, Khovd and Bayan-Olgii. The region has borders to Russia in the north, and China in the east and south. The combined population of the three provinces is around 267,000 (2013). Eastern parts of Uvs are at the distance of 850 km, and the most western point of Bayan-Olgii is 1,500 km away from the national capital Ulaanbaatar.

3. Western region is remote and sparsely populated. One of the first priorities of GoM is to develop infrastructure, especially roads and electricity supply in the region. Roads and transportation issues are essential for the development of region's natural resources. Whilst there are opportunities to develop small and medium-sized businesses, some of which are export oriented and trade with the neighbouring countries, there are rich mineral resources too. One of the most notable deposits is the Asgat silver deposit located 180 km north of the Bayan-Ulgii capital of Olgii. It is rich of silver but also has many accompanying base metals such as copper. It is listed as deposit of strategic importance to Mongolia and is being developed by GoM whilst also Russian companies take interest in the mine. Two large scale mines, Khotgor in Uvs and Khushuut mine in Khovd, the latter of which exports most of the coal to China.

4. As to electricity supply, the regional utility company, WRES SOJSC delivered around 130 MWh of electric energy in 2014. The growth of electricity supply to WES has been very high in recent years averaging around 25% for the last 5 years. Most of electricity was imported from Russian Federation; only some 40 GWh was delivered by Durgun hydro power plant. Technical losses are believed to be of the order of 18% - 20%.

5. The only generating capacity in WES is Durgun hydro power plant with 12 MW capacity. The Durgun hydro power plant was commissioned in 2008. It has 3 turbines with 4.3 MW capacity each. According to project documents it has ability to produce 30 GWh of electric energy per year. The actual operation data of Durgun hydro power plant for last years showed 24 GWh, 36 GWh and 39 GWh electricity output in 2012, 2013 and 2014, respectively. Most times the plant is operated with only one turbine in operation, and from time to time during peak hours with two generators in operation. The electric energy generation is highly dependent on precipitation and because the Mongolian climatic condition is very dry so in some years the hydro reservoirs do not get required amount of water from feeding rivers.

Figure G-1: Electricity Supply and Consumption of Western Energy System, 2014



6. The Western Energy System has a cross-border interconnection with Russia via a 260 km long 220 kV power transmission line operating at 110 kV voltage level. The main power substation with voltages of 110 kV, 35 kV and 10 kV is located in Ulaangom city of Uvs aimag. From this substation the three Aimag centers and other villages are supplied by 110, 35, 15 and 10 kV overhead power transmission lines.

7. The WES has eight 110/35/10 kV substations, fourteen 35/15 kV substations, 880 km of 110kV, 748 km of 35 kV and 1800 km of 15/10 kV power transmission lines. Due to long length and low loading of power transmission lines from the Russian federation, a significant amount of capacitance is observed in the line, which increases line voltage up to 125kV. In order to decrease such reactive power the 10 reactor shunts with capacity of 3.3 MVAR are used. The use of such large reactor shunts decreases the financial efficiency of the WES. A 35 kV line connects three southern soums to the Chinese grid.

Figure G-2: Western Region Energy System

8. As to electricity supply expansion, the region has primary energy resources in coal, hydropower, solar and wind. There is also the option of interconnecting the region to be supplied by CES, where electricity production is currently dominated by coal based thermal power. Utilization of renewable hydro, wind and solar resources stands, however, high in the priority. The option of

using coal is hampered by the low overall load and small heating loads in aimag centers, which makes thermal power and CHP options costly. The interconnection of WES to CES with a permanent and strong connection is also costly and scheduled far to the future.

9. The solar resource in the regions central and eastern parts is adequate with the total solar irradiation estimated between 1220-1600 kWh annually per square meter area. According to the wind energy atlas of Mongolia the most of the WES area is not suitable for utility scale wind power application. However, the landscape may create locations where the wind speeds are higher and suitable for wind generation due to funneling effects.

10. Hydropower is prospective for generation system expansion. There are ten identified hydropower sites in WES area, some of which have been investigated on feasibility study level, such as Erdeneburen for which a concept of 60 MW HPP has been studied. However, most of the large and medium size prospects have been put on-hold by MoE because of high cost or environmental issues or the studies continue with no definite deadline. Among the ten prospects, four small hydropower plants have been developed in the past, but all of them are now out of operation. These plants were run by soum administration and were not properly maintained in the lack of trained and experienced O&M staff.

2. Sub-Projects

11. The sub-Projects are as follows:-

- Component A – Solar PV plants (2 x 10 MW).
- Component B – Wind Turbines (1 x 5 MW)
- Component C – Small hydropower development (< 1 MW)
- Component D – Demonstration of Heat Pump technology (5 off in WES)
- Component E – Technical Assistance which includes (i) detailed feasibility study work and Environment and social safeguard assessment, (ii) renewable energy resource assessment including wind speed ground measurement, (iii) project monitoring and financial and operational capacity enhancement of WRES SOJSC, and (iv) pre-feasibility study work for candidate RE subprojects in WES, AuES, and EES under phase 2.

12. As to the sites of the planned solar PV power plants, the considerations include (i) proximity to load centres for minimizing T&D losses, (ii) easy access for transporting equipment and construction material, (iii) closeness to grid thus minimizing grid connection costs, and (iv) as close as possible to existing site of some utility operations with a view to utilizing staff already in place for the operation and maintenance of the facility. With these criteria, 110 kV substations in Umnugobi and Mayangad have been proposed.

13. For the wind turbines it is proposed that a few sites in Uvs aimag will be first investigated under a short 12-month measurement campaign. Should the results justify, up to 5 MW wind farm will be constructed.

14. The rehabilitation of small hydropower is proposed to be carried out for Uench hydro power plant. Sums Bulgan, Uench and Altai of Khovd are connected to independent power grid supplied by relatively expensive imported electricity from China. The small hydropower plant was originally built in 2006 but has not functioned well due to water intake design failure. A rehabilitation plan must be drawn and implements with the target of having the 930 kW in installed capacity connected to the nearby three soum centres by 35kV overhead transmission line.

15. Demand for electric heating is on rapid increase in western region. Shallow ground heat pump technology provides an opportunity to use electricity for heating in a more efficient manner. The technology is planned to be demonstrated in five suitable public sector buildings, such as Aimag government administration centers, schools or kindergartens.

3. Proposed Contribution to Initiating Transformation

16. The component will enable the transformation of other rural areas outside CES to a high penetration of renewable energy.

4. Implementation Readiness

17. A pre-feasibility study has been completed for the proposed SREP-supported investments. SREP funding approval is expected by the fourth quarter of calendar year 2016; the ensuing project would be scheduled for ADB Board consideration in the first quarter of 2017.

5. Rationale for SREP Financing

18. Upfront capital costs, technology risks, and off-take risks are major barriers to renewable electricity and heating services, which can be addressed with concessional financing. The project will demonstrate (i) the feasibility of distributed RE at very high penetration rates with incremental power output mainly from solar and wind; (ii) the feasibility of shallow ground heat pumps to reduce coal use for heating; and (iii) rehabilitation and operation of small hydropower systems. These activities will be supported by a capacity development TA to facilitate scaling up RE in other rural areas of Mongolia. Table G-1 presents performance and results indicators.

Table G-1: Performance and Results Indicators

Results	Indicators	Baseline	Targets	Means of Verification
SREP Project Outcomes				
1. Increased supply of renewable energy	Installed capacity	0	25 MW	Project review missions
	Design output	0	40 GW/h [a]	
2.Increased access to modern energy services	Number of women and men, businesses, and community services benefiting from SREP interventions	0	120,000 people [b] or around 20,000 households	Annual reports of utility companies
3. Increase in investments in renewable energy	US$ invested	0	US$ 60+ million by 2019	Annual reports of utility companies and government agencies
4. Greenhouse Gas emissions mitigated	CO_2 emissions reduced	0	> 32,000 tCO_2e/year by 2020 [c]	Ministry of Energy Ministry of Environment
SREP Inputs				
5. Capacity building activities	tbd	0	Milestones achieved conducted by 2018	Project implementation reports and review missions

CO_2 = carbon dioxide, GWh = Gigawatt-hour, MW = megawatt, tbd = to be determined, tCO2e = tons of carbon dioxide equivalence.

Notes: [a] Assumes 20 MW solar at 15% plant load factor and 5 MW wind at 30% plant load factor.

[b] Calculated based on 400 kWh per person per year consumption target and 5 people per household.

[c] Assumes 0.8 tCO_2e/MWh

6. Indicative Financing

Table G-2: Indicative Financing Plan
(US$ million)

	Private Sector	SREP			MDB[a]		GoM / WRES	TOTAL
		Total	ADB	WB	ADB	WB		
Investment Plan Components								
PHASE 1 - TRACK 1: Upscaling Rural Renewable Energy								
1. Solar PV power plants 2x10 MW	-	24.8	12.4	12.4	11.4	11.4	1.0	48.6
2. Wind energy plant 1 X 5 MW	-	-	-	-	11.5	-	0.5	12.0
3. Small hydropower development X 1	-	1.2	1.2	-	-	-	0.1	1.3
4. Shallow Ground Heat Pumps x 5	-	1.0	1.0	-	-	-	0.1	1.1
5. Technical assistance	-	1.5	1.0	0.5	-	-	0.2	1.7
Subtotal	**-**	**28.5**	**15.6**	**12.9**	**22.9**	**11.4**	**1.9**	**64.7**

ADB = Asian Development Bank, MW = megawatt, SREP = Scaling-up Renewable Energy for low-income countries Program, WRES = WRES State-Owned Joint Stock Company.

Notes:
[a] Financing by MDBs may be provided as either loan or grant (or both) depending on Mongolian government decision for utilizing country allocation of respective agencies.

7. Project Preparation Timetable

Table G-3: Project Milestones

Milestone	Date
SREP IP endorsement	Q4 / 2015
SREP funding approval	Q4 / 2016
ADB Board consideration	Q1 / 2017

8. Project Preparation Grant

19. The Government of Mongolia is requesting for two project preparatory grants of US$1,500,000 in total for preparation of Upscaling Rural Renewable Energy.

Table G-4: Project Preparation Grant Request

<table>
<tr><th colspan="5">SREP
Project Preparation Grant Request</th></tr>
<tr><td>Country/Region:</td><td colspan="2">Mongolia</td><td>CIF Project ID#:</td><td></td></tr>
<tr><td>Project Title:</td><td colspan="4">Upscaling Rural Renewable Energy</td></tr>
<tr><td>Tentative SREP Funding Request (in US million total) for Project at the time of Investment Plan submission (concept stage)::</td><td colspan="2">Grant: US$15.6 million</td><td colspan="2">Loan: $0</td></tr>
<tr><td>Preparation Grant Request (in US$):</td><td colspan="2">US$1.0 million</td><td colspan="2">MDB: Asian Development Bank</td></tr>
<tr><td>National Project Focal Point:</td><td colspan="4">Tovuudorj Purevjav, Director General, Energy Policy Department, Ministry of Energy</td></tr>
<tr><td>National Implementing Agency (project):</td><td colspan="4">Western Region Energy System State-Owned Joint Stock Company (WRES SOJSC) and National Renewable Energy Center (NREC).</td></tr>
<tr><td>MDB SREP Focal Point and Project Task Team Leader (TTL):</td><td colspan="2">SREP Focal Point:
Jiwan Acharya
Senior Climate Change Specialist (Clean Energy)
Asian Development Bank</td><td colspan="2">TTL:
Shigeru Yamamura
Senior Energy Specialist
East Asia Department
Asian Development Bank</td></tr>
<tr><td colspan="5">Description of activities covered by the preparation grant:
A preparation grant is required for:
(i) Detailed feasibility study for solar PV and wind power, small hydropower rehabilitation, and installation of shallow ground heat pumps.
(ii) Renewable energy resource assessment (solar and wind) which includes satellite imaginary data set analysis for last 5-10 years, and wind speed ground measurement.
(iii) Grid stability assessment and grid control strategy development including technical advisory and training for WRES grid operators.
(iv) Due Diligence which includes environment and social safeguard assessment, financial and economic analysis, and procurement and financial management capacity assessment including training.
(v) Project Identification and pre-feasibility study of candidate renewable energy subprojects for scaling up and replication in non-CES (such as WES, EES, and AuES).</td></tr>
<tr><td colspan="5">Outputs:</td></tr>
<tr><td colspan="2">Deliverable</td><td colspan="3">Timeline</td></tr>
<tr><td colspan="2">(a) Detailed FS</td><td colspan="3">10 months after Notice to Proceed (NTP)</td></tr>
<tr><td colspan="2">(c) Due Diligence Report</td><td colspan="3">10 months after NTP</td></tr>
</table>

(d) Grid Stability and Control Strategy	12 months after NTP
(e) Project identification and pre-feasibility	12 months after NTP
Budget (indicative):	
Expenditures	**Amount (US$) -** estimates
	Subcomponent 1
Consultants	$774,000
Equipment	$ 80,000
Local workshops/seminars	$ 8,000
Travel/transportation	$ 70,000
Others (admin costs/operational costs)	$20,000
Contingencies (max. 10%)	$48,000
Subtotal	**$1,000,000**
Other contributions:	
• Government	$100,000 (In-Kind)
• MDB	-
• Private Sector	-
• Others (please specify)	-
Total Cost	**$1,100,000**

Timeframe (tentative)

Submission of pre-appraisal document for SREP Sub-Committee Approval: *January 2017*

Expected Board/MDB Management approval date: *Project Preparation Technical Assistance approval: January 2016*

Other Partners involved in project design and implementation:

- WB, GIZ/SDA

If applicable, explanation for why the grant is MDB executed:

The Government of Mongolia has requested ADB to execute the grant due to its limited capacity in handling the timely contractual preparation of such a consultancy.

Implementation Arrangements (incl. procurement of goods and services)**:**

The executing agency will be the Ministry of Energy (MOE). The implementing agency will be the Western Region Energy System State-Owned Joint Stock Company (WRES-SOJSC, and National Renewable Energy Center (NREC). A Project Steering Committee (PSC) will be established to review project progress, coordinate inter-ministerial activities and guide the Project Management Unit (PMU), which will be established within MOE. The PMU will be supported by implementation consultants. All equipment and civil works procurement will be carried out in accordance with ADB's *Procurement Guidelines* (2010, as amended from time to time). Consultants will be recruited in line with ADB's *Guidelines on the Use of Consultants* (2010, as amended from time to time), through consulting firm or individual selection method. The procurement method would be international competitive bidding (ICB).

Table G-5: Project Preparation Grant Request

SREP Project Preparation Grant Request			
Country/Region:	Mongolia	**CIF Project ID#**:	
Project Title:	Upscaling Rural Renewable Energy - Solar PV Project		
Tentative SREP Funding Request (in US million total) for Project at the time of Investment Plan submission (concept stage)::	*Grant: US$12.9 million*	*Loan: $0*	
Preparation Grant Request (in US$):	US$0.5 million	MDB: World Bank	
National Project Focal Point:	Tovuudorj Purevjav, Director General, Energy Policy Department, Ministry of Energy		
National Implementing Agency (project):	Western Region Energy System State-Owned Joint Stock Company (WRES SOJSC) and National Renewable Energy Center (NREC).		
MDB SREP Focal Point and Project Task Team Leader (TTL):	*SREP Focal Point:* Karan Capoor Senior Energy Specialist World Bank	*TTL:* Peter Johansen Senior Energy Specialist World Bank	

Description of activities covered by the preparation grant:

A preparation grant is required for:

(i) Detailed feasibility study for a proposed 10 MW solar PV plant connected to Mongolia's Western grid;

(ii) Due diligence which includes environment and social safeguard assessment, financial and economic analysis, and procurement and financial management capacity assessment including training; and

(iii) Preparation of basic design and choice of implementation model.

Outputs:

Deliverable	**Timeline**
(a) Detailed FS	10 months after Notice to Proceed (NTP)
(c) Due Diligence Report	10 months after NTP
(d) Basic Design and Implementation Model Report	16 months after NTP

Budget (indicative):

Expenditures	**Amount (US$) -** estimates
	Subcomponent 1
Consultants	$425,000
Equipment	$0,000
Local workshops/seminars	$5,000
Travel/transportation	$35,000
Others (admin costs/operational costs)	$10,000
Contingencies (max. 10%)	$25,000
Subtotal	**$500,000**

Other contributions:	
• Government	$100,000 (In-Kind)
• MDB	-
• Private Sector	-
• Others (please specify)	-
Total Cost	**$600,000**

Timeframe (tentative)

SREP Sub-Committee approval: *November 2016*

World Bank Board approval: *March 2017*

Other Partners involved in project design and implementation:

- ADB

If applicable, explanation for why the grant is MDB executed:

The Government of Mongolia has requested WB to execute the grant due to its limited capacity in handling the timely contractual preparation of such a consultancy.

Implementation Arrangements (incl. procurement of goods and services)**:**

The executing agency will be the Ministry of Energy (MOE). The implementing agency will be the Western Region Energy System State-Owned Joint Stock Company (WRES-SOJSC, and National Renewable Energy Center (NREC). A Project Steering Committee (PSC) will be established to review project progress, coordinate inter-ministerial activities and guide the Project Management Unit (PMU), which will be established within MOE. The PMU will be supported by implementation consultants. All equipment and civil works procurement will be carried out in accordance with World Bank's *Procurement Guidelines*. Consultants will be recruited in line with World Bank's *Guidelines on the Use of Consultants*, through consulting firm or individual selection method.

Table G-6: ADB Upscaling Rural Renewable Energy –
MDB Request for Payment for Project Implementation Services (MPIS)

<table>
<tr><th colspan="5">SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES
MDB Request for Payment of Implementation Services Costs</th></tr>
<tr><td>1. Country/Region:</td><td>Mongolia</td><td>2. CIF Project ID#:</td><td colspan="2"></td></tr>
<tr><td>3. Project Title:</td><td colspan="4">Upscaling Rural Renewable Energy</td></tr>
<tr><td>4. Request for project funding (US$ million):</td><td colspan="2">At time of country submission (tentative): US$15.6 million (grant)</td><td colspan="2">At time of project approval:</td></tr>
<tr><td rowspan="2">5. Estimated costs for MDB project implementation services</td><td colspan="2" rowspan="2">Initial estimate - at time of Country submission: US$ 428,000

Final estimate - at time of project approval:</td><td colspan="2">MDB: Asian Development Bank</td></tr>
<tr><td colspan="2">Date: October 2015</td></tr>
<tr><td>6. Request for payment of MDB Implementation Services Costs:</td><td colspan="2">√ First tranche: US$ 214,000

☐ Second tranche: n/a</td><td colspan="2"></td></tr>
<tr><td>7. Project financing category:</td><td colspan="3">a - Investment financing - additional to ongoing MDB project
b- Investment financing - blended with proposed MDB project
c - Investment financing - stand-alone
d - Capacity building - stand alone</td><td>☐
√
☐
☐</td></tr>
<tr><td>8. Expected project duration (no. of years):</td><td colspan="4">5 years</td></tr>
<tr><td>9. Explanation of final estimate of MDB costs for implementation services:</td><td colspan="4">Not applicable</td></tr>
<tr><td colspan="5">10. Justification for proposed stand-alone financing in cases of above 6 c or d: not applicable</td></tr>
</table>

Table G-7: World Bank Solar PV Project –
MDB Request for Payment for Project Implementation Services (MPIS)

<table>
<tr><th colspan="5">SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES
MDB Request for Payment of Implementation Services Costs</th></tr>
<tr><td>1. Country/Region:</td><td>Mongolia / East Asia & Pacific</td><td>2. CIF Project ID#:</td><td colspan="2"></td></tr>
<tr><td>3. Project Title:</td><td colspan="4">Upscaling Rural Renewable Energy - Solar PV Project</td></tr>
<tr><td>4. Request for project funding (US$ million):</td><td colspan="2">At time of country program submission (tentative): Grant of US$ 12.4 million</td><td colspan="2">At time of project approval:</td></tr>
<tr><td rowspan="2">5. Estimated costs for MDB project implementation services</td><td colspan="2" rowspan="2">Initial estimate - at time of Country program submission: US$428,000

Final estimate - at time of project approval:</td><td colspan="2">MDB: World Bank</td></tr>
<tr><td colspan="2">Date: October 2015</td></tr>
<tr><td>6. Request for payment of MDB Implementation Services Costs:</td><td colspan="2">√ First tranche: US$128,000

☐ Second tranche: n/a</td><td colspan="2"></td></tr>
<tr><td>7. Project financing category:</td><td colspan="4">a - Investment financing - additional to ongoing MDB project ☐
b- Investment financing - blended with proposed MDB project √
c - Investment financing - stand-alone ☐
d - Capacity building - stand alone ☐</td></tr>
<tr><td>8. Expected project duration (no. of years):</td><td colspan="4">5 years</td></tr>
<tr><td>9. Explanation of final estimate of MDB costs for implementation services:</td><td colspan="4">If final estimate in 5 above exceeds the relevant benchmark range, explain the exceptional circumstances and reasons: n/a</td></tr>
<tr><td colspan="5">10. Justification for proposed stand-alone financing in cases of above 6 c or d: not applicable</td></tr>
</table>

Table G-8: World Bank Technical Assistance Project-
MDB Request for Payment for Project Implementation Services (MPIS)

<table>
<tr><th colspan="5">SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES
MDB Request for Payment of Implementation Services Costs</th></tr>
<tr><td>1. Country/Region:</td><td>Mongolia / East Asia & Pacific</td><td colspan="2">2. CIF Project ID#:</td><td></td></tr>
<tr><td>3. Project Title:</td><td colspan="4">Technical Assistance Project</td></tr>
<tr><td>4. Request for project funding (US$ million):</td><td colspan="2">At time of country program submission (tentative): Grant of US$ 1.2 million</td><td colspan="2">At time of project approval:</td></tr>
<tr><td rowspan="2">5. Estimated costs for MDB project implementation services</td><td colspan="2" rowspan="2">Initial estimate - at time of Country program submission: US$140,000

Final estimate - at time of project approval:</td><td colspan="2">MDB: World Bank</td></tr>
<tr><td colspan="2">Date: October 2015</td></tr>
<tr><td>6. Request for payment of MDB Implementation Services Costs:</td><td colspan="2">√ First tranche: US$70,000

☐ Second tranche: n/a</td><td colspan="2"></td></tr>
<tr><td>7. Project financing category:</td><td colspan="4">a - Investment financing - additional to ongoing MDB project ☐
b- Investment financing - blended with proposed MDB project ☐
c - Investment financing - stand-alone ☐
d - Capacity building - stand alone √</td></tr>
<tr><td>8. Expected project duration (no. of years):</td><td colspan="4">4 years</td></tr>
<tr><td>9. Explanation of final estimate of MDB costs for implementation services:</td><td colspan="4">If final estimate in 5 above exceeds the relevant benchmark range, explain the exceptional circumstances and reasons: n/a</td></tr>
<tr><td colspan="5">10. Justification for proposed stand-alone financing in cases of above 6 c or d: It is anticipated that the stand-alone Technical Assistance Project will be executed by the World Bank.</td></tr>
</table>

ANNEX H. INDEPENDENT QUALITY REVIEW

The matrix below presents the reviews and comments of Mr. Mike Allen, external reviewer, based on the draft investment plan dated 3rd September 2015. The review of the Investment Plan for Mongolia has been undertaken ahead of the submission of the plan to the SREP Sub-Committee. The matrix also presents the responses from the Government and the SREP technical team on the comments raised by the external reviewer.

Comments	Responses
General Comments on the Investment Plan	
The Investment Plan is well prepared, pragmatic and appears to propose realistic and potentially achievable outcomes.	Thank you.
The Investment Proposal in itself is thorough and comprehensive. It is apparent that a good deal of effort has gone into the background research, stakeholder consultation and evaluation of potential options that could be supported under SREP funding in Mongolia.	Thank you.
In addition to considering the specific SREP opportunities, the IP provides a valuable analysis of the unique central issue around integrating renewables into the rigid electricity system that exists in Mongolia. This is fundamental to building a realistic programme for long term RE development in Mongolia; it should not discourage efforts to grow the renewables portion of energy supply, rather it provides a much needed reality check about the special challenges that exist.	Thank you, and agreed.
The IP contains an annex which spends considerable effort analyzing the issue of curtailment within the Mongolian power system which is relatively rigid in terms of the plants' ability to adjust to varying loads.	Agreed. The State Policy of Energy (2015-2030) recently approved by the parliament confirms to address such multiple challenges to reduce electricity import, meet growing load demand, and increase RE capacity.

Comments	Responses
This highlights a number of issues around plant operations and in particular grid constraints. These issues can be overcome but present a perhaps unique additional challenge for Mongolia in looking to reduce its fossil dependency, increase renewables and cut back on its consumption from Russian power supplies.	These challenges can be overcome together with MDBs on a basis of the IP.
A fundamental feature of the Mongolian energy system is that it has a combined role of delivering heat and power. *The winter climate is extremely harsh with winter daytime temperatures ranging from -10°C to -30°C (late December and January). Temperatures can drop to as low as -40°C at night. The heating season is unusually long at eight months and as a consequence a reliable heating service is not merely a utility for citizens; it is literally a matter of life and death. A safe, clean, and reliable heating supply is a critical need for the entire population of Mongolia.* Because of this situation there are additional challenges in replacing fossils fuels and/or utilising renewable energy sources. The grid integration of renewables is often hampered by the fact that existing generation plant (coal fired) is not designed to load follow; this has led to renewables being curtailed through operational difficulties, or financial penalties incurred by generators when long period shutdown / restarts of thermal plant would become necessary. Although a Feed in Tariff (FiT) regime exists it is not operating effectively and carries a near term legacy of underfunding generators as compensation for their FiT was at year	Agreed. Challenges and measures to overcome constraints in curtailment and FiT payments were also discussed in Annex A and D. Proposed activities in Phase1-Track 2: strengthening renewable energy regulations will directly address those constraints to support ongoing regulatory reform. The Government has already initiated regulatory reform to address curtailment and sustainable FiT payment. Two-part tariff system which has been introduced since July 2015 will lead to (i) incentivize CHP to play a role in load following mode, and (ii) change in dispatching regime from average to marginal cost basis. An introduction of RE surcharge under amended RE law in June 2015 is also expected to give greater confidence in sustainable FiT payments.

Comments	Responses
end. This is being addressed through restructuring of payment arrangements but has yet to be fully resolved. In turn this situation has discouraged renewable project developers, concerned about their supply being curtailed (full production not accepted for dispatch) and will limit the growth in such developments where system operational constraints persist. Interconnection to Russia provides limited additional capacity to overcome these issues.	
A concern raised during the review reflects the following comments in the IP: *The solar PV, wind energy and mini-hydro projects are assumed to be financially feasible under Mongolia's FiT tariffs. The local state-owned electric utility company WRES SOJSC is currently in poor financial standing and operating at a loss. As sales are forecast to grow and the marginal cost of sales is higher than the revenues, the losses will accumulate to very high levels resulting in an ever-increasing fiscal burden to the central government. Therefore, there is a pressing need to increase tariffs whilst simultaneously seeking better operational efficiency and reduced costs.* *The SREP support to the planned investments together with the law-based FiT payments from the government support fund for RE generators, would, de facto, improve the financial status of WRES SOJSC. If FiT payments are paid to a state-owned RE generator entity from the government fund as it is paid to private RE companies, part of the direct subsidies now paid annually to WRES SOJSC would be replaced by law-based revenues, thus improving the company's financial standing. In addition, power purchase bills from Russia and China will be reduced. Finally, higher operational efficiency through reduced transmission losses would bring about additional benefits to WRES SOJSC.*	Agreed. Proposed SREP technical assistance in Phase 1-Track 1 helps enhance financial and managerial capacity of WES SOJSC. With regard to management skills, it covers an isolated region where management has clearly been resourceful in providing a stable power supply. There is a complex load shedding system in place that operates successfully on occasions when supply from Russia is lost. The very cold winters and harsh climate pose another challenge in maintaining the electricity network but the performance statistics indicate that the company does well. The poor financial status of the company is a reflection of a social policy that restricts revenue by keeping tariffs affordable, it is not a reflection of the financial capacity of management. But, recent tariff reform (involving tariff increase, introduction of tariff indexation, and of two part tariff), which is also applicable to WRES, is significant step to put it on financially self-sustainable.

<table>
<tr><th>Comments</th><th>Responses</th></tr>
<tr><td>Clearly there needs to be confirmation that WRES SOJSC has the financial and managerial capacity to execute the projects as outlined. It also appears that there may be some uncertainty about the FiT regime as it applies to state owned entities and this is central to the suggestion that the SREP funded projects would enhance the financial strength of the company. Care should also be taken to ensure that if SREP funds support CAPEX on projects the operation of these projects can be commercially effected by WRES SOJSC.</td><td></td></tr>
<tr><td colspan="2">The Country Energy Policy</td></tr>
<tr><td>There is limited coverage in the IP around detailed energy policy but the following note outlines the targets that the SREP support would underwrite:

The proposed SREP investments will support the government's target of increasing the share of RE in the country's energy mix. The following key policies, listed in chronological order from past to present, define the target levels for increasing RE in Mongolia's energy system:
The National Renewable Energy Programme (2005-2020) approved by the State Great Khural (Parliament of Mongolia) with its eleven paragraphs has a goal to increase the penetration of renewable energy in the energy system of Mongolia, improve the structure of power supply, and utilize renewable energy in off-grid soums (districts) and settlements to ensure ecological balance and improve the economic efficiency. The programme lists both broad policy actions and individual investment projects for implementation. The programme aims at gradually increasing the share of renewable energy in total energy production to reach 3-5 percent by 2010 and 20-25 percent by 2020.
The implementation plan for the first phase of National Action Program on Climate Change (NAPCC) 2011-2021, was approved in 2011. In the first phase (2011-2016), among the many actions NAPCC states under Strategic Objective 3 "Mitigate GHG emissions and establish low carbon economy</td><td>Detailed energy policy and issues including recent regulatory reforms are also included in Annex A. Full effect of ongoing regulatory reform is still permeating to gain confidence among potential private investors in RE development to achieve 30% of RE share in 2030.

Proposed SREP activities in Phase1-Track 2: strengthening renewable energy regulations will address to establish stronger foundation to create enabling and sustainable environment in RE development.</td></tr>
</table>

Comments	Responses
through the introduction of environmentally friendly technologies and improvement in energy effectiveness and efficiency" and in particular to "Develop wind and solar energy production systems" (Action 3.3.4).	
Proposed SREP Programme	
The programme outlined for SREP support has quite specific targets, reflecting the considerations outlined earlier. What is being proposed is that SREP funds would be directed towards activities in the Western Energy System (WES): • *The establishment of RE sources of 25 MW (20 MW solar PV, 5 MW wind) in the Western Energy System. The load growth of WES indicates that growth will continue around 9% annually. With this estimate the SREP project could contribute to obtaining around 19 % of electricity to the region from the new RE plants. With the growth in demand met by Russian import or other conventional sources, the share of electricity supply from these solar PV, wind and hydro plants would decrease to 14% and 8% by 2025 and 2030 respectively.* • *The refurbishment of Uench micro-hydro HPP will demonstrate that existing hydropower resources can be recovered and maintained to the benefit of local soum communities.* • *SREP funding will support the creation of jobs related to the construction/installation, operation and maintenance of renewable technologies. Education of the workforce in the deployment of these technologies will be a feature of the Western Energy System RE project.* The key projects as outlined above appear to be reasonable, given the noted concerns on their execution and operation. There are a number of institutional and operational issues that are elaborated in the IP and	Thank you. As responded to similar previous comment, proposed SREP technical assistance in Phase 1-Track 1 will address institutional and operational issues outlined in the IP.

Comments	Responses
these would be expected to be considered in more detail if the funds are approved to support these projects.	
Financing	
The level of funding sought and the outcomes projected appear realistic, given limited experience in grid connected PV activities. The focus on the WES should allow a focused approach in a region where private sector interest is low; within the CES it is acknowledged that SREP funds would add little value given existing private sector activities. The support of MDBs needs to be tested to ensure that commitments are in place before SREP funds are released.	ADB and the World Bank are fully committed to proposed SREP activities to support GoM broader energy sector objectives as well as specific renewable energy development targets outlined in the IP.
Compliance with SREP Goals	
1. Catalyze increased investments in renewable energy The nature of the energy market in Mongolia is clearly not entirely conducive to major renewable energy investments. There are existing approved wind projects in the CES that require final clarification on tariff and dispatch before they will proceed. The proposed SREP support into the WES will help demonstrate the viability of renewables in similar environments but the challenges of integration into the existing fossil dominated system may remain. Any real catalyzing of increased investment will require the success of these pending projects and clarity on tariffs, curtailment and payment.	Agreed. On top of proposed SREP activities in the IP to upscale rural renewable energy and to strengthen renewable energy regulations, building large hydropower as regulating capacity is necessary to create sufficient room for RE integration into the grid. The Government has already started project preparation for Egiin hydropower plant construction which will be funded by the Government of China.

Comments	Responses
2. Implementation capacity The financial weakness of WES SOJCS has been identified as a concern. Its recovery is particularly dependent on the opportunity for the SREP funded PV projects to attract an elevated tariff under the FiT regime. This needs to be confirmed as there appears to be some uncertainty as to whether a state owned entity will qualify for the FiT.	The Government has confirmed that FiT is applicable to proposed PV projects, and level of FiT will be determined by Energy Regulatory Commission upon completion of Feasibility Study.

3. Improve the long-term economic viability of the renewable energy sector The renewable energy sector in Mongolia has to date been largely focused on off grid SHS and wind activities. The IP lists a number of private sector entities that are working to develop wind farms but there are no grid connected solar farms, as yet though some are apparently being considered. There are policy and regulatory issues that need resolution; a number of "stalled" projects are noted but attention appears to be directed at resolving the issues that they are facing. Given the complexity of grid integration with the inability of existing thermal plant to provide a variable load, it is clear that the contribution that renewables will make is important but only part of the near term solution. It is argued that progress will be encouraged as the number of RE installations increases, building confidence within the power industry and the general public. From this point of view SREP's contribution will be important. While SREP funded activities will help drive a more focused and sustainable basis for future growth; there needs to be increased private sector engagement and this will only occur, on a sustained basis, when regulatory and pricing signals are clear and acceptable to the market. SREP funds must therefore be directed into projects where conditions are conducive to ensuring such outcomes.	Agreed. Proposed SREP activities in Phase1-Track 2: strengthening renewable energy regulations will address to establish stronger foundation to create enabling and sustainable environment in private sector led RE development.

Comments	Responses
4. Transformative impact The targeted nature of the proposed SREP investments in Mongolia is seen as pragmatic given the current energy market status, issues around the structure and operation of the electricity system and a need to enhance the enabling environment. Given the renewable sector is relatively immature it is not expected that there will be major transformations in the market through SREP alone; if well managed and executed the proposed programme should help encourage the wider renewable energy sector in the country. Experience suggests that demonstration projects with specialist funding, such as SREP, will not necessarily ensure that an attractive commercial market place results quickly.	Thank you, and agreed. The Government is confident that ongoing regulatory reform and scaling up rural renewable energy with an assistance of SREP funding will create strong foundation to widely deploy renewable energy in the country.
Recommendations	
The Investment Proposal in itself is thorough and comprehensive. It is apparent that a good deal of effort has gone into the background research, stakeholder consultation and evaluation of potential options that could be supported under SREP funding in Mongolia.	Thank you.
The level of funding sought and the outcomes projected appear realistic, given limited experience in grid connected PV activities. The focus on the WES should allow a focused approach in a region where private sector interest is low; within the CES it is acknowledged that SREP funds would add little value given existing private sector activities.	Thank you.
In addition to considering the specific SREP opportunities, the IP	Thank you.

Comments	Responses
provides a valuable analysis of the unique central issue around integrating renewables into the rigid electricity system that exists in Mongolia. This is fundamental to building a realistic programme for long term RE development in Mongolia; it should not discourage efforts to grow the renewables portion of energy supply, rather it provides a much needed reality check about the special challenges that exist.	
It will be important to confirm the commitments from other donors are available to ensure that the proposed projects can proceed in a timely and effective fashion.	As responded in previous similar comment, ADB and the World Bank are fully committed to proposed SREP activities to support GoM broader energy sector objectives as well as specific renewable energy development targets outlined in the IP.

Climate Investment Fund – Scaling-up Renewable Energy Programme (SREP)
Investment Plan for Mongolia
Review undertaken by: Dr Mike Allen
10th September 2015

Introduction

The review of the Investment Plan for Mongolia has been undertaken ahead of the submission of the plan to the SREP Sub-Committee of the Strategic Climate Funds, within the Climate Investment Funds at the World Bank.

These notes are based on a review of the draft plan dated 3rd September 2015. A number of minor queries have been raised by email and the responses are taken into account in these notes.

It should be noted that the reviewer has not visited Mongolia as part of this review, nor been involved in the preparation of this plan. The lack of a visit to Mongolia and any contact with the ministries, agencies, institutions and various stakeholders necessarily limits the personal background knowledge. The reviewer has limited familiarity with the energy issues facing Mongolia (though some through involvement with the SREP Expert Panel) other than from personal research.

The Investment Plan is well prepared, pragmatic and appears to propose realistic and potentially achievable outcomes.

In the Central Energy System (CES) there are five active private wind power projects totalling 350 MW of capacity. All have government approval and their readiness allows construction to starts in 2016, only one project does not yet have an approved tariff. All of the projects are commercial in nature and feasible without SREP financing. In principle once institutional issues related to Feed-in-Tariff payments, dispatch order and curtailment and issues related to substation expansion are resolved, the projects can proceed on their own merits.

Looking to develop solutions in an area away from where there is current private sector activity reflects that a conscious decision has been taken to avoid directing SREP resources at the present impasse around a number of issues facing renewables in the CES:

> *… although there are barriers to RE development, (i) the existing policy regime appears to be reasonably successful in terms of mobilizing private sector investment in utility-scale grid-connected RE projects, (ii) there is limited or no value addition for SREP in the current private sector development queue, and (iii) there is limited potential value addition for concessional finance in the CES at present. Considering the current RE development status, and the overall SREP objectives for promoting RE capacity and output, access to energy, and productive end use of energy,*
>
> *GoM believes that limited SREP resources should be directed toward projects in Non CES*

systems in poor regions which are heavily dependent on electricity imports from neighbouring countries, and are not attractive to private sector developers and investors, though may be less commercial in the near term but which have large replication and scale-up potential. At the same time, issues associated with the regulatory environment and central government policy are barriers for large private sector projects in CES.[13]

A fundamental feature of the Mongolian energy system is that it has a combined role of delivering heat and power.

The winter climate is extremely harsh with winter daytime temperatures ranging from -10°C to -30°C (late December and January). Temperatures can drop to as low as -40°C at night. The heating season is unusually long at eight months and as a consequence a reliable heating service is not merely a utility for citizens; it is literally a matter of life and death. A safe, clean, and reliable heating supply is a critical need for the entire population of Mongolia.

Because of this situation there are additional challenges in replacing fossils fuels and/or utilising renewable energy sources. The grid integration of renewables is often hampered by the fact that existing generation plant (coal fired) is not designed to load follow; this has led to renewables being curtailed through operational difficulties, or financial penalties incurred by generators when long period shutdown / restarts of thermal plant would become necessary. Although a Feed in Tariff (FiT) regime exists it is not operating effectively and carries a near term legacy of underfunding generators as compensation for their FiT was at year end. This is being addressed through restructuring of payment arrangements but has yet to be fully resolved. In turn this situation has discouraged renewable project developers, concerned about their supply being curtailed (full production not accepted for dispatch) and will limit the growth in such developments where system operational constraints persist. Interconnection to Russia provides limited additional capacity to overcome these issues.

Fortunately Mongolia has a high potential for renewables; impressive wind resources, “massive” solar potential and hydro.

To date the only large scale wind project developed in Mongolia has been the 50 MW Salkhit wind farm located 70km from Ulaanbaatar. Wind farms are under development in Sainshand (52 MW), Tsetsii (50 MW) and Choir (50 MW). In addition to these large projects, there are more than 4000 small-scale wind turbines in use by herders in rural areas.

Despite the success of small scale solar PV systems supplying nomadic herders, there are currently no large-scale grid connected solar PV projects in the country. Several utility-scale grid-connected solar PV projects are planned and under development by the private sector. Solar district heating is being pilot-tested in a few locations. Although solar radiation levels are not at levels typical for concentrated solar power (CSP), there is potential to integrate concentrating solar thermal systems with district heating and possibly for industrial applications.

In recent years hydropower development in Mongolia has been focused mainly on the

[13] Extracts from IP shown in italics throughout these notes.

development of a large scheme of several hundred megawatts. Such a scheme is considered necessary to Mongolia to regulate daily power production in the CES instead of continuing to rely on Russia. Otherwise there are no known small HPP developments considered as viable by the Ministry of Energy's licensing team.

The IP contains an annex which spends considerable effort analysing the issue of curtailment within the Mongolian power system which is relatively rigid in terms of the plants' ability to adjust to varying loads. This highlights a number of issues around plant operations and in particular grid constraints. These issues can be overcome but present a perhaps unique additional challenge for Mongolia in looking to reduce its fossil dependency, increase renewables and cut back on its consumption from Russian power supplies.

Specific Comments on Investment Plan

N. 2.1 The Country Energy Policy

There is limited coverage in the IP around detailed energy policy but the following note outlines the targets that the SREP support would underwrite:

The proposed SREP investments will support the government's target of increasing the share of RE in the country's energy mix. The following key policies, listed in chronological order from past to present, define the target levels for increasing RE in Mongolia's energy system:

- *The National Renewable Energy Programme (2005-2020) approved by the State Great Khural (Parliament of Mongolia) with its eleven paragraphs has a goal to increase the penetration of renewable energy in the energy system of Mongolia, improve the structure of power supply, and utilize renewable energy in off-grid soums (districts) and settlements to ensure ecological balance and improve the economic efficiency. The programme lists both broad policy actions and individual investment projects for implementation. The programme aims at gradually increasing the share of renewable energy in total energy production to reach 3-5 percent by 2010 and 20-25 percent by 2020.*
- *The implementation plan for the first phase of National Action Program on Climate Change (NAPCC) 2011-2021, was approved in 2011. In the first phase (2011-2016), among the many actions NAPCC states under Strategic Objective 3 "Mitigate GHG emissions and establish low carbon economy through the introduction of environmentally friendly technologies and improvement in energy effectiveness and efficiency" and in particular to "Develop wind and solar energy production systems" (Action 3.3.4).*

O. 2.2 Proposed SREP Programme

The programme outlined for SREP support has quite specific targets, reflecting the considerations outlined earlier. What is being proposed is that SREP funds would be directed towards activities in the Western Energy System (WES):

- *The establishment of RE sources of 25 MW (20 MW solar PV, 5 MW wind) in the Western Energy System. The load growth of WES indicates that growth will continue around 9% annually. With this estimate the SREP project could contribute to obtaining around 19 % of electricity to the region from the new RE plants. With the growth in demand met by Russian import or other conventional sources, the share of electricity supply from these solar PV, wind and hydro plants would decrease to 14% and 8% by 2025 and 2030 respectively.*

- *The refurbishment of Uench micro-hydro HPP will demonstrate that existing hydropower resources can be recovered and maintained to the benefit of local soum communities.*
- *SREP funding will support the creation of jobs related to the construction/installation, operation and maintenance of renewable technologies. Education of the workforce in the deployment of these technologies will be a feature of the Western Energy System RE project.*

The key projects as outlined above appear to be reasonable, given the noted concerns on their execution and operation. There are a number of institutional and operational issues that are elaborated in the IP and these would be expected to be considered in more detail if the funds are approved to support these projects.

P. 2.3 Financing

The table that follows summarises the anticipated SREP financing and anticipated co-financing:

Table 6: Upscaling Rural RE Costs and Sources of Financing ($ million)

		Private Sector	SREP	ADB[a]	World Bank[a]	GoM	Total
Investment Plan Components							
PHASE 1 - TRACK 1: Upscaling Rural Renewable Energy							
1	Solar PV power plants 2x10 MW	-	24.8	11.4	11.4	1.0	48.6
2	Wind energy plant 1 X 5 MW	-	-	11.5	-	0.5	12.0
3	Rehabilitation of small hydropower	-	0.6	-	-	0.1	0.7
4	Shallow Ground Heat Pumps x 5	-	1.4	-	-	0.1	1.5
5	Technical assistance	-	2.2	-	-	0.2	2.4
	TOTAL	**-**	**29.0**	**22.9**	**11.4**	**1.9**	**65.2**

The support of MDBs needs to be tested to ensure that commitments are in place before SREP funds are released.

A concern raised during the review reflects the following comments in the IP:

The solar PV, wind energy and mini-hydro projects are assumed to be financially feasible under Mongolia's FiT tariffs. The local state-owned electric utility company WRES SOJSC is currently in poor financial standing and operating at a loss. As sales are forecast to grow and the marginal cost of sales is higher than the revenues, the losses will accumulate to very high levels resulting in an ever-increasing fiscal burden to the central government. Therefore, there is a pressing need to increase tariffs whilst simultaneously seeking better operational efficiency and reduced costs.

The SREP support to the planned investments together with the law-based FiT payments from the government support fund for RE generators, would, de facto, improve the financial status of WRES SOJSC. If FiT payments are paid to a state-owned RE generator entity from the government fund as it is paid to private RE companies, part of the direct subsidies now paid annually to WRES SOJSC would be replaced by law-based revenues, thus improving the company's financial standing. In addition, power purchase bills from Russia and China will be reduced. Finally, higher operational efficiency through reduced transmission losses would bring about additional benefits to WRES SOJSC.

Clearly there needs to be confirmation that WRES SOJSC has the financial and managerial capacity to execute the projects as outlined. It also appears that there may be some uncertainty about the FiT regime as it applies to state owned entities and this is central to the suggestion that the SREP funded projects would enhance the financial strength of the company. Care should also be taken to ensure that if SREP funds support CAPEX on projects the operation of these projects can be commercially effected by WRES SOJSC.

Compliance with SREP Goals

Key focuses within the SREP programme can be summarised under the following headings; the response of the IP to each of these aspects is noted in the following comments.

5. **Catalyse increased investments in renewable energy:**

The nature of the energy market in Mongolia is clearly not entirely conducive to major renewable energy investments. There are existing approved wind projects in the CES that require final clarification on tariff and dispatch before they will proceed. The proposed SREP support into the WES will help demonstrate the viability of renewables in similar environments but the challenges of integration into the existing fossil dominated system may remain. Any real catalysing of increased investment will require the success of these pending projects and clarity on tariffs, curtailment and payment.

6. **Enabling environment:**

As noted, the enabling environment has areas of confusion, particularly around the FiT regime, dispatch and statement of opportunity (clarifying whether additional RE generation can be added to the system). In addition the cost of finance in Mongolia for such projects can be unreasonable high undermining the commercial viability of projects. It is unclear how these issues are being addressed but there does appear to be a recognition amongst stakeholders that RE opportunities risk being undermined.

7. **Increase energy access:**
8.

The need for increased access to energy is clear. The SREP support will help accelerate this in some areas but is also being targeted at grid connected supply which generally may have limited impact on improving access at an individual level.

9. **Implementation capacity:**

The financial weakness of WES SOJCS has been identified as a concern. Its recovery is particularly dependent on the opportunity for the SREP funded PV projects to attract an elevated tariff under the FiT regime. This needs to be confirmed as there appears to be some uncertainty as to whether a state owned entity will qualify for the FiT.

10. **Improve the long-term economic viability of the renewable energy sector:**

The renewable energy sector in Mongolia has to date been largely focused on off grid SHS and wind activities. The IP lists a number of private sector entities that are working to develop wind farms but there are no grid connected solar farms, as yet though some are apparently being considered.

There are policy and regulatory issues that need resolution; a number of “stalled” projects are noted but attention appears to be directed at resolving the issues that they are facing. Given the complexity of grid integration with the inability of existing thermal plant to provide a variable load, it is clear that the contribution that renewables will make is important but only part of the near term solution.

It is argued that progress will be encouraged as the number of RE installations increases, building confidence within the power industry and the general public. From this point of view SREP’s contribution will be important.

While SREP funded activities will help drive a more focused and sustainable basis for future growth; there needs to be increased private sector engagement and this will only occur, on a sustained basis, when regulatory and pricing signals are clear and acceptable to the market. SREP funds must therefore be directed into projects where conditions are conducive to ensuring such outcomes.

11. Transformative impact:

The targeted nature of the proposed SREP investments in Mongolia is seen as pragmatic given the current energy market status, issues around the structure and operation of the electricity system and a need to enhance the enabling environment. Given the renewable sector is relatively immature it is not expected that there will be major transformations in the market through SREP alone; if well managed and executed the proposed programme should help encourage the wider renewable energy sector in the country. Experience suggests that demonstration projects with specialist funding, such as SREP, will not necessarily ensure that an attractive commercial market place results quickly.

Comments and Recommendations

The Investment Proposal in itself is thorough and comprehensive. It is apparent that a good deal of effort has gone into the background research, stakeholder consultation and evaluation of potential options that could be supported under SREP funding in Mongolia.

The level of funding sought and the outcomes projected appear realistic, given limited experience in grid connected PV activities. The focus on the WES should allow a focused approach in a region where private sector interest is low; within the CES it is acknowledged that SREP funds would add little value given existing private sector activities.

In addition to considering the specific SREP opportunities, the IP provides a valuable analysis of the unique central issue around integrating renewables into the rigid electricity system that exists in Mongolia. This is fundamental to building a realistic programme for long term RE development in Mongolia; it should not discourage efforts to grow the renewables portion of energy supply, rather it provides a much needed reality check about the special challenges that exist.

It will be important to confirm the commitments from other donors are available to ensure that the proposed projects can proceed in a timely and effective fashion.