Technical Assistance Report

Project Number: 51282-001
Knowledge and Support Technical Assistance (KSTA)
August 2018

Mongolia: Energy Storage Option for Accelerating Renewable Energy Penetration

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Asian Development Bank

CURRENCY EQUIVALENTS
(as of 4 July 2018)

Currency unit	–	togrog (MNT)
MNT1.00	=	$0.0004
$1.00	=	MNT2,462.5000

ABBREVIATIONS

ADB	–	Asian Development Bank
CES	–	Central Energy System
MW	–	megawatts
GWh	–	gigawatt hours
TA	–	technical assistance

NOTE
In this report, "$" refers to United States dollars.

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KNOWLEDGE AND SUPPORT TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data — **Project Number:** 51282-001

Project Name	Energy Storage Option for Accelerating Renewable Energy Penetration	**Department/Division**	EARD/EAEN
Nature of Activity	Policy Advice, Research and Development	**Executing Agency**	Ministry of Energy
Modality	Regular		
Country	Mongolia		

2. Sector — **Subsector(s)**

ADB Financing ($ million)	
Total	**0.00**

3. Strategic Agenda — **Subcomponents**

Inclusive economic growth (IEG)	Pillar 1: Economic opportunities, including jobs, created and expanded
Environmentally sustainable growth (ESG)	Eco-efficiency Global and regional transboundary environmental concerns Natural resources conservation Urban environmental improvement

Climate Change Information

Climate Change impact on the Project	Low

Cofinancing

Mitigation ($ million)	0.50

4. Drivers of Change — **Components**

Governance and capacity development (GCD)	Institutional development
Knowledge solutions (KNS)	Application and use of new knowledge solutions in key operational areas Knowledge sharing activities
Partnerships (PAR)	Foundations Official cofinancing

Gender Equity and Mainstreaming

No gender elements (NGE)	✓

5. Poverty and SDG Targeting

Geographic Targeting	No
Household Targeting	No
SDG Targeting	Yes
SDG Goals	SDG7, SDG9, SDG13

Location Impact

Not Applicable

6. Risk Categorization Low

7. Safeguard Categorization Safeguard Policy Statement does not apply

8. Financing

Modality and Sources	Amount ($ million)
ADB	**0.00**
None	0.00
Cofinancing	**0.50**
Republic of Korea e-Asia and Knowledge Partnership Fund (Full ADB Administration)	0.50
Counterpart	**0.00**
None	0.00
Total	**0.50**

I. INTRODUCTION

1. The knowledge and support technical assistance (TA) will accelerate the penetration of renewable energy in the Central Energy System (CES) in Mongolia by (i) assessing the status and supply-demand projection of electricity and heat in the CES, (ii) identifying innovative energy-storage technologies, (iii) assessing the market potential for energy storage, and (iv) developing an energy-storage deployment strategy.[1]

2. The TA is included in the country operation business plan for Mongolia, 2018–2020 of the Asian Development Bank (ADB).[2] The TA is fully aligned with ADB's country partnership strategy for Mongolia, 2017–2020,[3] which prioritizes improving natural resource management and broadening climate change response to support government priorities outlined in the Mongolia Sustainable Development Vision 2030.[4] The TA will also support the strategic priorities of ADB's Strategy 2030[5] to mitigate climate change and enhance environmental sustainability.[6]

II. ISSUES

3. Secure and reliable energy supply and sustainable development are Mongolia's two biggest challenges. Mongolia's energy system is largely dependent on coal, with combined heat and power plants the major sources of power and heating. Installed power capacity in 2015 was 1,106 megawatts (MW); estimated power generation in 2017 and consumption in 2016 were 5.5 gigawatt hours (GWh) and 7.1 GWh, respectively.[7] Current power capacity has not been sufficient to meet the demand for power, particularly during peak hours in mid-winter time, and all fast ramping requirements and spinning reserve for frequency regulation and supply shortages[8] are dependent on imports from the Russian grid.[9]

4. Additional investments in energy capacity in Mongolia are required to keep up with the growing energy demand. Considering Mongolia's upward population growth and its rapid pace of economic development, the heat demand in Ulaanbaatar is expected to grow 3.3% annually from 2017 to 2030, from 1,803 gigacalories per hour to 2,748 gigacalories per hour. Power demand is expected to grow 3.3% annually from 1,019 MW in 2017 to 1,561 MW in 2030.[10]

5. Accelerating renewable energy and increasing the share of renewables in the energy mix is vital for Mongolia to develop a sustainable energy infrastructure and to achieve security of energy supply. To address the widening supply–demand gap and to strengthen energy

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[1] The CES is Mongolia's largest and the most complex energy system, covering the main cities of Ulaanbaatar, Darkhan, Erdenet, and 13 provinces, and equipped with six thermal power plants and one wind farm.

[2] ADB. 2018. *Country Operations Business Plan: Mongolia, 2018–2020.* Manila; the TA's name has been changed from "Heat and Energy Storage Option for Accelerating Renewable Energy Penetration" to better reflect the nature of the TA.

[3] ADB. 2017. *Country Partnership Strategy: Mongolia, 2017–2020.* Manila.

[4] State Great Hural of Mongolia. 2016. *Mongolia Sustainable Development Vision 2030.* Ulaanbaatar.

[5] ADB. 2018. *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*. Manila.

[6] The TA first appeared in the business opportunities section of ADB's website on 31 May 2018.

[7] Central Intelligence Agency. 2018. *The World Factbook. 2018.* Washington, D.C. https://www.cia.gov/library/publications/the-world-factbook/geos/mg.html

[8] "Ramping" is the ability of a power plant in increasing or decreasing output to accommodate power demand. Spinning reserve is the on-line reserve capacity that is synchronized to the grid system and ready to meet electric demand within 10 minutes of a dispatch instruction by a system operator. Spinning Reserve is needed to maintain system frequency stability during emergency operating conditions and unforeseen load swings.

[9] The Government of Mongolia's priority is to build reservoir hydropower. ADB has supported a detailed engineering design for this; however, because of environmental concerns for Lake Baikal, it has not progressed.

[10] ADB. 2013. *Mongolia: Updating the Energy Sector Development Plan.* Manila.

independence in a sustainable manner, the Government of Mongolia has formulated a series of policies to increase the share of renewables in the energy mix. The State Policy on Energy, 2015–2030 approved by Parliament in 2015, intends to achieve energy independence and to increase the share of renewable energy to 20% of total installed capacity in 2023 and 30% in 2030.[11] To meet these mid- to long-term targets, renewable energy capacity of 633 MW by 2023 and 1,085 MW by 2030 will be required.[12] However, currently as the CES has no spinning reserve (para. 3), it can only absorb up to 220–250 MW of solar photovoltaic and 125–175 MW of wind power capacity at a 20% curtailment rate with the combined heat and power plants' operating load following mode.[13] In future, the power system will not be able to integrate all proposed renewable capacities since higher share of renewables will result in great uncertainty and variability in the supply–demand balance. This requires enhancing the flexibility of the system by introducing options such as energy storage in the power system.[14]

6. Energy-storage technologies can offer a high flexibility at both temporal and spatial scales for integration of electricity and heat systems. They are valuable in most energy systems to (i) improve the efficiency of the energy system; (ii) help integrate higher levels of variable renewable resources; (iii) enhance energy access; and (iv) improve electricity grid stability, flexibility, reliability, and resilience.[15] The TA will support identification of technically feasible and financially viable energy-storage technologies within the Mongolian energy system, and the development of viable business solutions for scaling up their deployment.

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

7. The TA is aligned with the following impact: Mongolia's renewable energy capacity increased.[16] The TA will have the following outcome: increased readiness for investment in energy-storage technologies.[17]

B. Outputs, Methods, and Activities

8. **Output 1: Status and supply-demand projection of electricity and heat in the CES assessed.** The TA will conduct the following activities: (i) analyze historical and current heat and power load curves at different temporal scales, (ii) forecast future locations of renewable energy capacity and heat and power supply curves based on existing renewable energy development plan, (iii) evaluate the effect of added generation capacity on grid stability, and (iv) investigate the dynamics of prices for power and heating. Through this output, consultants will assess supply and demand of heat and power in the CES, and will identify opportunities for energy-storage

[11] In 2014, the share of installed capacity of combined heat and power plants, hydro, wind, diesel genset, and small-scale renewable energy was 85%, 2%, 5%, 7%, and 1%. International Renewable Energy Agency. 2016. *Renewable Readiness Assessment: Mongolia.* Abu Dhabi.

[12] Government of Mongolia. 2015. *Scaling-up Renewable Energy Programme for Low-Income Countries: Investment Plan for Mongolia.* Ulaanbaatar.

[13] In an energy system, curtailment is the reduction of output of a renewable resource below what it could have otherwise produced. Variable renewable energy generation is often curtailed when its output is beyond the level the grid system can absorb. Higher curtailment rate indicates lower utilization of renewables and is an impeding factor in integrating renewables into the power system. Load following modes mean that a power plant adjusts its output as demand for electricity fluctuates throughout the day.

[14] International Energy Agency. 2017. *Getting Wind and Sun onto the Grid: A Manual for Policy Makers.* Paris.

[15] International Energy Agency. 2014. *Technology Roadmap: Energy Storage.* Paris.

[16] Government of Mongolia. 2015. *State Policy on Energy 2015–2030.* Ulaanbaatar.

[17] The design and monitoring framework is in Appendix 1.

technologies to (i) reduce renewable energy curtailment rate, (ii) increase future share of renewable energy in capacity and generation, (iii) reduce fossil fuel consumption, and (iv) increase grid stability.

9. **Output 2: Technically feasible energy-storage technologies identified.** The TA will conduct the following activities: (i) perform market research on energy-storage technologies; and (ii) identify technically feasible energy-storage technologies for various purposes. Applications of energy-storage technologies should include but not be limited to (i) frequency regulation, (ii) voltage support, (iii) load following, (iv) load leveling, (v) peak shaving and valley filling, (vi) demand shifting and peak reduction, and (vii) seasonal storage.

10. **Output 3: Market potential for energy storage assessed.** The TA will conduct the following activities: (i) assess the economic and financial viability of power and heat storage technologies comparing levelized cost of energy with storage against prices for power and heating, (ii) propose viable business solutions for deployment of energy-storage technologies, (iii) undertake a cost–benefit analysis of proposed technologies, and (iv) estimate avoidable power imports and coal consumption for power and heat generation by energy storage technologies.

11. **Output 4: Energy-storage deployment strategy developed.** The TA will conduct the following activities: (i) develop a midterm energy-storage deployment strategy, (ii) prepare a feasibility study on deployment of energy-storage technologies in the CES, and (iii) organize a workshop on energy-storage technologies and their business potential in the CES.

C. Cost and Financing

12. The TA is estimated to cost $500,000, which will be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund and administered by ADB. The key expenditure items are listed in Appendix 2.

13. The TA will finance operational expenses related to eligible activities of the fund's Implementation Guidelines.[18] It will not be used for (i) civil works, (ii) procurement of large-scale equipment, (iii) permanent staffing costs, or (iv) hiring of staff consultants, unless otherwise agreed between the Government of the Republic of Korea and ADB.

14. The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, information and documents relevant for the preparation of the TA, and other in-kind contributions.

D. Implementation Arrangements

15. ADB will administer the technical assistance. ADB's Energy Division, East Asia Department will select, administer, and supervise the consulting firm's outputs for the TA, and evaluate the consulting firm. The implementation arrangements are summarized in the table below.

[18] Eligible activities include: (i) concept development of potential ADB projects by enhancing readiness, capacity building, policy advice/dialogue and pre-feasibility studies; (ii) policy reform and institutional capacity building; (iii) studies, research, and analytical work; (iv) dissemination, networking, and cross-learning; and (v) innovative approaches promoting high level technologies and Information and communication technologies.

Implementation Arrangements

Aspects	Arrangements		
Indicative implementation period	September 2018–January 2020		
Executing agency	Ministry of Energy		
Implementing agency	Ministry of Energy		
Consultants	To be selected and engaged by ADB		
	QCBS	Consulting firm	$500,000
Disbursement	The TA resources will be disbursed following ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time).		

ADB = Asian Development Bank, QCBS = quality- and cost-based selection, TA = technical assistance.
Source: ADB estimates.

16. **Consulting services.** ADB will engage the consultants following the ADB Procurement Policy (2017, as amended from time to time) and its associated project administration instructions and/or staff instructions.[19]

17. **Cofinancier requirements.** ADB prepares the following reports: (i) a project completion report (filed within 1 year of project completion using the form provided by the Government of the Republic of Korea) and (ii) annual financial and implementation reports. Upon request of the Government of the Republic of Korea, ADB prepares and submits an assessment report to the government on the TA supported by the fund. The government may ask the TA supervising unit to supply detailed information on the status of the fund's supported projects, including the consultant's reports, or to arrange a special mission as part of monitoring and evaluation of the fund's operations.

IV. THE PRESIDENT'S DECISION

18. The President, acting under the authority delegated by the Board, has approved the Asian Development Bank administering technical assistance not exceeding the equivalent of $500,000 to the Government of Mongolia to be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund for Energy Storage Option for Accelerating Renewable Energy Penetration, and hereby reports this action to the Board.

[19] Terms of Reference for Consultants (accessible from the list of linked documents in Appendix 3).

DESIGN AND MONITORING FRAMEWORK

Impact the TA is Aligned with Renewable energy capacity increased[a]			
Results Chain	**Performance Indicators with Targets and Baselines**	**Data Sources and Reporting Mechanisms**	**Risks**
Outcome Readiness for investments in energy-storage technologies increased	By 2020: a. One project on energy storage proposed (2018 baseline: 0) b. One policy recommendation on energy storage made by the Ministry of Energy (2018 baseline: 0)	a. National energy plan b. Government report by Ministry of Energy	Government's commitment to renewable-energy development not sustained Unfavorable policy on energy storage emerged
Outputs 1. Status and supply-demand projection of electricity and heat in the CES assessed	1a. Report on CES assessment prepared by 2019 (2018 baseline: 0)	1a. Report on CES assessment	Capacity of local counterparts diminished
2. Technically feasible energy-storage technologies identified	2a. At least three energy-storage technologies proposed by 2019 (2018 baseline: 0)	2a. Report on appropriate energy-storage options	
3. Market potential for energy storage assessed	3a. At least one business solution proposed by 2019 (2018 baseline: 0)	3a. Report on market potential of energy storage and a mid- and long-term energy-storage deployment strategy	
4. Energy-storage deployment strategy developed	4a. One energy-storage deployment strategy and one feasibility study prepared by 2019 (2018 baseline: NA)	4a. Report on market potential of energy storage and a mid- and long-term energy-storage deployment strategy	
	4b. 50% of workshop participants reporting enhanced understanding of energy-storage-technology applications by 2020 (2018 baseline: NA)	4b. Feedback questionnaire administered after the workshop	

Key Activities with Milestones

1. Status and supply-demand projection of electricity and heat in the CES assessed

1.1 Analyze historical and current heat and power load curves at different temporal scales (October 2018).
1.2 Forecast future locations of renewable energy capacity and heat and power supply curves (October 2018).
1.3 Evaluate effects of added generation capacity on grid stability (November 2018).
1.4 Investigate the dynamics of prices for power and heating (November 2018).
1.5 Draft report on the CES assessment (January 2019).

2. Technically feasible energy-storage technologies identified

2.1 Perform market research on energy-storage technologies (January 2018).
2.2 Identify technically feasible energy-storage technologies for various purposes (March 2019).
2.3 Draft report on energy-storage options (April 2019).

3. Market potential for energy storage assessed

3.1 Assess economic and financial viability of energy-storage technologies, comparing the levelized cost of energy with storage against prices for power and heating (May 2019).
3.2 Propose viable business solutions for deployment of energy-storage technologies (June 2019).
3.3 Undertake a cost–benefit analysis of proposed technologies (June 2019).
3.4 Estimate avoidable power imports and coal consumptions for power and heat generation by energy storage technologies (June 2019).

4. Energy-storage deployment strategy developed

4.1 Develop a mid- and long-term energy-storage deployment strategy (September 2019).
4.2 Prepare a feasibility study on deployment of energy-storage technologies in the CES (December 2019).
4.3 Organize a workshop on energy-storage technologies and their business potential in the CES (January 2020).

Inputs

Republic of Korea e-Asia and Knowledge Partnership Fund: $500,000.

Note: The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, domestic transportation, and other in-kind contributions.

Assumptions for Partner Financing

NA

CES = Central Energy System, NA = not applicable, TA = technical assistance
[a] Government of Mongolia. 2015. *State Policy on Energy 2015–2030*. Ulaanbaatar.
Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN
($'000)

Item	Amount
Republic of Korea e-Asia and Knowledge Partnership Fund[a]	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	235.5
ii. National consultants	82.1
b. Out-of-pocket expenditures	
i. International and local travel	64.8
ii. Reports and communications	10.0
2. Training, seminars, workshops, forum, and conferences[b]	69.0
3. Contingencies	38.6
Total	**500.0**

Note: The technical assistance (TA) is estimated to cost $500,000, comprising contributions from the Republic of Korea e-Asia and Knowledge Partnership Fund presented in the table above. The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, information and documents relevant for the preparation of the TA, and other in-kind contributions. The value of the government contribution is estimated to account for 10% of the total TA cost.

[a] Administered by the Asian Development Bank.

[b] Training will include one overseas study tour in ADB members' countries for government officials to acquire experience in application of energy-storage technologies. The overseas study tour is subject to ADB's approval.

Source: Asian Development Bank estimates.

LIST OF LINKED DOCUMENTS

http://www.adb.org/Documents/LinkedDocs/?id=51282-001-TAReport

1. Terms of Reference for Consultants