



Technical Assistance Report

Project Number: 48030-001
Policy and Advisory Technical Assistance (PATA)
November 2015

Mongolia: Strategy for Northeast Asia Power System Interconnection

(Cofinanced by the Climate Change Fund, the People's Republic of China Regional Cooperation and Poverty Reduction Fund, and the Republic of Korea e-Asia and Knowledge Partnership Fund)

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Asian Development Bank

CURRENCY EQUIVALENTS

(as of 30 October 2015)

Currency unit	–	togrog (MNT)
MNT1.00	=	\$0.00050
\$1.00	=	MNT1995.5

ABBREVIATIONS

ADB	–	Asian Development Bank
NAPSI	–	Northeast Asia power system interconnection
PRC	–	People's Republic of China
TWh	–	terawatt-hour
TA	–	technical assistance
UESDP	–	Updating Energy Sector Development Plan

NOTE

In this report, "\$" refers to US dollars.

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POLICY AND ADVISORY TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data		Project Number: 48030-001	
Project Name	Strategy for Northeast Asia Power System Interconnection	Department /Division	EARD/EAEN
Country	Mongolia	Executing Agency	Ministry of Energy
2. Sector		Financing (\$ million)	
✓ Energy	Electricity transmission and distribution		1.75
		Total	1.75
3. Strategic Agenda		Climate Change Information	
Inclusive economic growth (IEG)	Pillar 1: Economic opportunities, including jobs, created and expanded	Climate Change impact on the Project	Low
Environmentally sustainable growth (ESG)	Eco-efficiency		
Regional integration (RCI)	Pillar 1: Cross-border infrastructure		
4. Drivers of Change		Gender Equity and Mainstreaming	
Knowledge solutions (KNS)	Knowledge sharing activities	No gender elements (NGE)	✓
Partnerships (PAR)	Civil society organizations International finance institutions (IFI) Official cofinancing		
5. Poverty Targeting		Location Impact	
Project directly targets poverty	No	Nation-wide	High
6. TA Category:		B	
7. Safeguard Categorization Not Applicable			
8. Financing			
Modality and Sources		Amount (\$ million)	
ADB		0.75	
Policy and advisory technical assistance: Climate Change Fund		0.75	
Cofinancing		1.00	
Republic of Korea e-Asia and Knowledge Partnership Fund		0.50	
PRC Regional Coop. and Poverty Reduction Fund		0.50	
Counterpart		0.00	
None		0.00	
Total		1.75	
9. Effective Development Cooperation			
Use of country procurement systems		No	
Use of country public financial management systems		No	

I. INTRODUCTION

1. During discussions for the Asian Development Bank (ADB) country operations business plan for 2015,¹ the Government of Mongolia sought ADB technical assistance (TA) to prepare a strategy for Northeast Asia power system interconnection (NAPSI) using Mongolia's abundant renewable energy.² The TA is aligned with ADB's Energy Policy in its promotion of renewable energy development and regional power sector integration.³ The TA is also aligned with Strategy for Regional Cooperation in the Energy Sector of Central Asia Regional Economic Cooperation Countries.⁴ The design and monitoring framework is in Appendix 1.

II. ISSUES

2. The power sector is the single largest source of greenhouse gas emissions in Northeast Asia. A low-carbon transformation is needed to lessen reliance on fossil fuels and reduce the carbon footprint. The region as a whole has sufficient renewable sources to meet demand, but the limited connectivity of power systems among countries poses a major challenge. Each jurisdiction has unique power utility ownership, tariff policies, market design and regulations, and other institutional frameworks that are not well coordinated or harmonized, which inhibits interconnection. As a result, despite abundant energy sources many jurisdictions in Northeast Asia suffer from energy shortages or meet their energy needs at a high cost, resulting in high electricity prices for consumers, and burdening economic activities.

3. Power systems that are well interconnected would improve system flexibility and efficiency and allow system optimization, and thereby capture resource complementarities, bring economies of scale into investments, improve fuel security, enable greater renewable energy penetration, and reduce power system carbon emissions. An interconnected system would also provide more reliable and affordable electricity to consumers, enhance economic activities, and improve the competitiveness of economies, thus underpinning regional sustainable growth; this has been demonstrated by a number of other successful interconnected regional power systems (e.g., in the Greater Mekong Subregion). At present there is no such interconnected power market in Northeast Asia,⁵ even though it is home to some of the world's largest and most prosperous economies. Mongolia is in a unique position to spur economic growth by developing its vast energy resources to meet the power demands of its more prosperous neighbors through power exports. However, in the absence of an interconnected power system, Mongolia lacks access to large neighboring markets, and thus to investment in its energy resources and power system development. There is a need to undertake a comprehensive analysis and chart out a clear strategy for Mongolia for power system interconnections in Northeast Asia.⁶

¹ ADB. 2015. *Country Operations Business Plan: Mongolia, 2015*. Manila.

² The Northeast Asia power system includes the People's Republic of China (PRC), Japan, the Republic of Korea, and Mongolia, and potentially includes Kazakhstan and the Russian Federation. The TA first appeared in the business opportunities section of ADB's website on 18 August 2015.

³ ADB. 2009. *Energy Policy*. Manila.

⁴ ADB. 2008. *Strategy for Regional Cooperation in the Energy Sector of CAREC Countries*. Manila.

⁵ The PRC exports a small amount of electricity to neighboring countries (e.g., the Republic of Korea and Mongolia). Mongolia exports a small amount of excess electricity at night to the Russian Federation for the purpose of grid stability.

⁶ Existing regional energy sector cooperation initiatives are (i) the Greater Tumen Initiative, with participation by the PRC, the Republic of Korea, Mongolia, and the Russian Federation; and (ii) One Belt One Road, linking the PRC with Mongolia and the Russian Federation. However, these initiatives have not conducted a comprehensive analysis that includes all Northeast Asian countries and set out strategies for regional power interconnection.

4. Historically, power consumption and gross domestic product have grown in tandem. Development of a cost-effective, sustainable power supply would enable continued growth in Northeast Asia. Advanced and emerging economies in this subregion—e.g., the People’s Republic of China (PRC), Japan, the Republic of Korea—have high gross domestic product and electricity consumption.⁷ Along with rapid economic growth, the PRC in particular has shown tremendous growth in power demand, which is projected to double by 2040.⁸ Japan and the Republic of Korea rely on imported fossil fuels and will need low-carbon energy imports to meet their climate change targets.⁹

5. On the other hand, Mongolia has tremendous renewable energy potential, especially wind and solar. Some 10% of Mongolia’s land area (over 160,000 square kilometers) is estimated to have good to excellent wind potential for utility-scale applications (power density of 400–600 watts per square meter). According to conservative estimates by the National Renewable Energy Laboratory of Mongolia, at a capacity rate of 7 megawatts per square kilometer, this area of Mongolia has the potential to support more than 1,100 gigawatts of installed capacity. In addition, Mongolia averages 270–300 sunny days per year. The South Gobi region has average annual solar radiation of 1,400 kilowatt-hours per square meter, with a solar intensity of 4.3–4.7 kilowatt-hours per square meter. The wind and solar power potential are estimated to be equivalent to 2,600 gigawatts of installed capacity, or 5,457 terawatt-hours of annual power generation (equivalent to 27% of global electricity consumption in 2014).¹⁰ If one-third of this wind and solar potential was exploited, Mongolia could supply about 25% of combined annual electricity demand of the PRC, Japan, and the Republic of Korea. Using abundant and diversified resources, Mongolia could serve as a core power supplier to neighboring countries, while improving power security and driving sustainable prosperity. Power system interconnection would be an ideal and comprehensive solution to reduce power system carbon emissions in Northeast Asia.

6. Three key drivers for an integrated power network in the subregion are the (i) demand–supply imbalance within Northeast Asian countries; (ii) availability of economical, sustainable power generation resources in a resource-rich country such as Mongolia, which justifies export; and (iii) close proximity of Northeast Asian countries, which makes cross-country power interconnection and trade feasible. Power system interconnection by low-loss, high-voltage direct current transmission lines would allow transmission of electricity from Mongolia to demand centers in neighboring countries. However, the existing transmission line infrastructure in Mongolia is decrepit and requires significant investment for high-voltage direct current transmission lines; Mongolia cannot afford this investment on its own, and will have to leverage investments from multilateral development banks emerging climate financing mechanism and private sector participation.

7. There are serious institutional challenges to power market integration, including (i) the need for closer alignment of national and regional investment decisions, which are currently independent; (ii) differences in countries’ regulatory environments; (iii) inadequate regional institutions; (iv) the need to maintain long-term commitments in frequently changing political frameworks; (v) national sovereignty and energy independence concerns; and (vi) the need to

⁷ Total electricity consumption in Northeast Asia in 2014 was around 6,675 terawatt-hours (TWh), including 5,200 TWh in the PRC, 950 TWh in Japan, 520 TWh in the Republic of Korea, and 5 TWh in Mongolia. A majority of the region’s electricity is generated using fossil fuel: 77% in the PRC, 87% in Japan, 66% in the Republic of Korea, and 95% in Mongolia.

⁸ International Energy Agency. 2014. *World Energy Outlook 2014*. Paris.

⁹ Energy imports satisfy about 89% of Japan’s energy demand, and 97% of demand in the Republic of Korea.

¹⁰ National Renewable Energy Laboratory. 2009. *Mongolia Renewable Energy Resource Assessment*. Ulaanbaatar.

mobilize private sector investments for highly uncertain subregional power market development. A prerequisite to integration is a comprehensive study that can address these challenges, provide plausible cost–benefit scenarios, and demonstrate benefit sharing across countries.¹¹ A thorough assessment would enable a regionally planned investment to be developed and priority projects to be identified. Given the sensitive geopolitical situation in Northeast Asia, a bottom-up approach that engages nongovernmental institutions and the private sector is preferable.

8. The Government of Mongolia hosted the first regional conference on power system interconnection in November 2012, which was attended by nongovernment organizations, research institutes, and private sectors from the subregion. Following the conference, the government, nongovernment organizations, and research institutes requested ADB support to (i) conduct analytical studies to prepare a road map for power system interconnection in Northeast Asia; and (ii) raise awareness, build consensus and increase engagement among nongovernment organizations, research institutes, and the private sector in the subregion regarding the importance of power interconnection with its extensive sector work throughout the sub-region. ADB is the most suitable institution to foster power system interconnection in the subregion. The government established a task force in April 2014 under the Ministry of Energy on the Asian Super Grid,¹² which is an important element of Mongolia’s development agenda. Other subregion stakeholders expressed strong interest in a future NAPSI, and ADB is exploring potential partnerships with some institutions.¹³ This TA can help enhance regional cooperation and integration, both in Northeast Asia and through the Central Asia Regional Economic Cooperation regional framework by closely coordinating with its activities.¹⁴

III. THE PROPOSED POLICY AND ADVISORY TECHNICAL ASSISTANCE

A. Impact and Outcome

9. The impacts of the TA will be (i) carbon footprints of the power system in Northeast Asia reduced, (ii) power system in Northeast Asia optimized, and (iii) stakeholders’ agreement reached on the NAPSI Steering Committee plan.¹⁵ The outcome of the TA will be a strategy and an action plan road map for the NAPSI prepared utilizing Mongolia’s vast energy resources.

B. Methodology and Key Activities

10. The outputs of the TA will be (i) power systems and markets in the Northeast Asian countries assessed, (ii) power system interconnection projects prioritized and an investment plan developed, (iii) Mongolia’s renewable energy capacity expansion plan to export clean

¹¹ A detailed and comprehensive study on the regional power trade does not exist, but there are (i) some bilateral power trade studies between the PRC and Mongolia, including ADB. 2002. *Technical Assistance Completion Report: Strategic Study on Development Options for Economic Cooperation between Mongolia and the People’s Republic of China (PRC) in the Eastern Parts of Inner Mongolia Autonomous Region, PRC and Mongolia*. Manila; and ADB. 2009. *Development of Regional Cooperation Programs for Mongolia and the People’s Republic of China*. Consultant’s report. Manila (TA 6370-PRC); and (ii) a literature review—Energy Charter. 2014. *Gobitec and Asian Super Grid for Renewable Energies in Northeast Asia*. http://www.energycharter.org/fileadmin/DocumentsMedia/Thematic/Gobitec_and_the_Asian_Supergrid_2014_en.pdf.

¹² Potential regional interconnections of electrical grids and related infrastructure to allow the trading of power, in particular, but not exclusively, electricity generated from renewable resources across Northeast Asia.

¹³ ADB is having initial discussions with the Korea Electric Power Corporation, Soft Bank, and Hanns Seidel Foundation.

¹⁴ The ongoing Central Asia and South Asia regional electricity market can be further linked to the Northeast Asia market (ECASAREM).

¹⁵ Potential members include government institutions, nongovernment organizations, and the private sector.

electricity analyzed, (iv) knowledge sharing and consensus building for the NAPSI steering committee implemented, and (v) a regional knowledge and investment platform for the NAPSI steering committee initiated.

C. Cost and Financing

11. The TA is estimated to cost \$2,012,000, of which \$750,000 will be financed on a grant basis by the Climate Change Fund,¹⁶ \$500,000 will be financed on a grant basis by the People's Republic of China Regional Cooperation and Poverty Reduction Fund and administered by ADB, and \$500,000 will be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund and administered by ADB. The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, secretarial assistance, domestic transportation, and other in-kind contributions. The proceeds of the TA will be disbursed in line with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time). The detailed cost estimates and financing plans are in Appendix 2.

D. Implementation Arrangements

12. The TA will be implemented over 25 months, from 15 January 2016 to 15 February 2018. The executing agency will be the Ministry of Energy. The implementing agency will be the National Renewable Energy Center. The Ministry of Energy and the National Renewable Energy Center will provide support to the consultants, including (i) bilingual counterpart personnel available to work full time, if required; (ii) assistance with visas, accommodation, and other permits required by the consultants to enter and to work in Mongolia; (iii) assistance in the arrangement of workshops and conferences; and (iv) access to all data—including documents, reports, accounts, and drawings and maps—and permission to enter offices, as appropriate and necessary, to undertake the work. An advance payment facility will be provided for workshops, training, seminars, and conferences to be held in Ulaanbaatar.¹⁷

13. The TA will require the following consulting services to achieve project outputs: (i) outputs 1 and 2 will require 14.2 person-months of consulting services (3 international consultants for 14.2 person-months), while output 3 will require 42.8 person-months of consulting services (5 international consultants for 12.8 person-months and 5 national consultants for 30 person-months); and (ii) outputs 4 and 5 will require 25 person-months of consulting services (3 international consultants for 15 person-months and 1 national consultant for 10 person-months). Consultants for outputs 1, 2, and 3 will be engaged through a firm using quality- and cost-based selection (90:10) method with full technical proposal. Consultants for outputs 4 and 5 will be engaged using individual consultant selection in accordance with the Guidelines on the Use of Consultants (2013, as amended from time to time) of ADB. ADB's Procurement Guidelines (2015, as amended time to time) will be followed and the shopping method will be used to procure equipment under the TA. Equipment used by consultants during TA implementation will be turned over to the executing agency upon completion of the TA. The terms of reference for consultants are in Appendix 3.

14. The TA will be monitored through (i) consultant progress reports, and (ii) ADB TA review missions. Quarterly consultation meetings will be organized for inception, interim, and draft final

¹⁶ Established by the Asian Development Bank.

¹⁷ The executing agency successfully managed funds using an advance payment facility to complete activities and liquidate advances in the course of two previous ADB-financed TA projects.

outputs with all concerned officials from the government, development partners, nongovernment organizations, and private sector invited to disseminate findings and receive comments.

IV. THE PRESIDENT'S DECISION

15. The President, acting under the authority delegated by the Board, has approved ADB administering technical assistance not exceeding the equivalent of (i) \$750,000 to be financed on a grant basis by the Climate Change Fund, (ii) \$500,000 to be financed on a grant basis by the People's Republic of China Regional Cooperation and Poverty Reduction Fund, and (iii) \$500,000 to be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund to the Government of Mongolia for the Strategy for Northeast Asia Power System Interconnection, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Impacts the Project is Aligned with Carbon footprints of the power system in Northeast Asia reduced. Power system in Northeast Asia optimized. Stakeholders' agreement on the Northeast Asia power system interconnection plan reached.			
Project Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting Mechanisms	Risks
Outcome A strategy and an action plan road map for the Northeast Asia power system interconnection (NAPSI) prepared utilizing Mongolia's vast energy resources	a. NAPSI steering committee, a regional knowledge and investment platform, is fully operational ^a by 2020 (2015 baseline: 0) b. The proposed Mongolia's strategy and its action plan is endorsed and adopted by the NAPSI steering committee by 2020 (2015 baseline: 0)	a–b. NAPSI steering committee annual report	Slow progress in reaching consensus on action plan among stakeholders.
Outputs 1. Power systems and markets in the Northeast Asian countries assessed 2. Power system interconnection projects prioritized and investment plan developed 3. Mongolia's renewable energy capacity expansion plan to export clean electricity analyzed 4. Knowledge sharing and consensus building for the NAPSI implemented 5. A regional knowledge and investment platform for the NAPSI initiated	1a. A detailed study is prepared by April 2017 (2015 baseline:0) 2a. A detailed action plan is prepared by April 2018 (2015 baseline: 0) 3a. A renewable energy capacity expansion plan is developed by April 2017 (2015 baseline:0) 4a. At least four international workshops and conferences held by April 2018 (2015 baseline:0) 5a. At least four discussions are held with regional institutions, including the Central Asia Regional Economic Cooperation, regarding the possibility of establishing a steering committee for NAPSI, by April 2018 (2015 baseline:0)	1a. Consultant's report 2a. Consultant's report 3a. Consultant's report 4a. Proceedings of workshops and/or conferences 5a. Meeting minutes	Technical assistance implementation delayed due to lack of cooperation and information sharing among stakeholders.

Key Activities with Milestones**Output 1. Power systems and markets in the Northeast Asian countries assessed**

- 1.1 Conduct analytical studies including political, economic, technical, institutional, and legal aspects (Q2 2016–Q2 2017).
- 1.2 Hold stakeholder consultation meetings to collect and incorporate their feedbacks (Q2 2016–Q1 2017).

Output 2. Power system interconnection projects prioritized and investment plan developed

- 2.1 Identify key actors and stakeholders for the NAPSI (Q2 –Q4 2016).
- 2.2 Set up NAPSI steering committee (Q4 2016–Q1 2017).
- 2.3 Organize and hold NAPSI steering committee meetings to discuss the findings of a comprehensive analysis of Northeast Asia power systems and markets; and brainstorm and develop Mongolia's strategy for NAPSI and identify short-, medium-, and long-term priority actions (Q4 2016–Q3 2017).
- 2.4 Draft and gather feedback and comments on Mongolia's strategy and action plan from a wider range of stakeholders (Q2 2017–Q2 2018).
- 2.5 Finalize Mongolia's strategy for NAPSI, and a detailed action plan that identifies pilot investment projects and investment strategies (Q4 2017–Q2 2018).

Output 3. Mongolia's renewable energy capacity expansion plan to export clean electricity analyzed

- 3.1 Conduct a wind and solar resource assessment (Q2–Q4 2016).
- 3.2 Analyze the cost of energy and select clean energy technologies (Q4 2016–Q1 2017).
- 3.3 Update the domestic investment plan for transmission line and associated facility refurbishment (Q2–Q4 2016).
- 3.4 Select sites for renewable energy plants for power export, schedule planting, and costing (Q4 2016–Q1 2017).
- 3.5 Develop Mongolia's renewable energy capacity expansion plan to export clean electricity (Q1–Q2 2017).

Output 4. Knowledge sharing and consensus building for the Northeast Asia power system interconnection implemented

- 4.1 Identify and engage active key actors and stakeholders for the NAPSI (Q2 2017–Q2 2018).
- 4.2 Plan and organize international workshops and conferences on the NAPSI (Q2 2016–Q2 2018).
- 4.3 Initiate the creation of a regional knowledge platform (Q2 2016–Q2 2018).

Output 5. A regional knowledge and investment platform for the Northeast Asia power system interconnection initiated

- 5.1 Identify some regional institutions that may have interest in the NAPSI and invite these institutions for knowledge sharing and consensus-building workshops and conferences (Q2 2016–Q2 2018).
- 5.2 Initiate discussions on the possibility of establishing a regional knowledge and investment platform (Q2 2016–Q2 2018).

Inputs

Climate Change Fund: \$750,000

The People's Republic of China Regional Cooperation and Poverty Reduction Fund: \$500,000

The 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, secretarial assistance, domestic transportation, and other in-kind contributions.

Assumptions for Partner Financing

Not applicable.

^a Hold an annual meeting to discuss and agree on short and midterm action plan and budgetary allocation.

Source: Asian Development Bank estimates.

COST ESTIMATES AND FINANCING PLAN
(\$'000)

Item	Amount
A. Climate Change Fund^a	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	330.0
ii. National consultants	40.0
b. International and local travel	94.0
c. Reports, translations, and communications	12.0
2. Equipment (computer, printer, etc.) ^b	80.0
3. Workshops, training, seminars, and conferences ^c	97.0
4. Surveys	25.0
5. Representative for contract negotiations	5.0
6. Miscellaneous administration and support costs ^d	6.0
7. Contingencies	61.0
Subtotal (A)	750.0
B. People's Republic of China Regional Cooperation and Poverty Reduction Fund^e	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	328.0
ii. National consultants	120.0
b. International and local travel	52.0
Subtotal (B)	500.0
C. Republic of Korea e-Asia and Knowledge Partnership Fund^f	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	275.0
b. International and local travel	94.0
c. Reports, translations, and communications	8.0
2. Workshops, training, seminars, and conferences ^c	78.0
3. Miscellaneous administration and support costs ^d	4.0
4. Contingencies	41.0
Subtotal (C)	500.0
Total (A+B+C)	1,750.0

Note: The technical assistance (TA) is estimated to cost \$2,012,000, of which contributions from the Climate Change Fund, the People's Republic of China's Regional Cooperation and Poverty Reduction Fund, and the Republic of Korea e-Asia Knowledge Partnership Fund are presented in the table above. The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, secretarial assistance, domestic transportation, and other in-kind contributions. The value of government contribution is expected to account for 13% of the total TA cost.

^a Established by the Asian Development Bank. Funds will be used for outputs 1, 2, 4, and 5 jointly with the Republic of Korea e-Asia Knowledge Partnership Fund, which is calculated on pro-rata basis.

^b Equipment breakdown: wind speed ground measurement equipment (2): \$60,000; solar irradiation ground measurement equipment (2): \$20,000. To be turned over to the executing agency upon completion of TA activities.

^c ADB will review and approve detailed workshops, training, seminars, and conferences. An advance payment facility will be provided for those held in Ulaanbaatar. Includes travel costs or ADB staff acting as resource persons and/or facilitators. Workshops are as follows: inception workshop: Ulaanbaatar; midterm workshop: Beijing; draft final workshop: Seoul; final workshop: Tokyo; investment forums (two): Ulaanbaatar and/or Manila; project implementation training (four): Ulaanbaatar.

^d Includes costs for data acquisition and translation.

^e Administered by the Asian Development Bank. Fund will be used for output 3.

^f Administered by the Asian Development Bank. Fund will be used for outputs 1, 2, 4, and 5 jointly with the Climate Change Fund, which is calculated on pro-rata basis.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. **Output 1: A Comprehensive Study on the Power Systems and Markets in the Northeast Asian Countries and Output 2: Mongolia's Strategy and Action Plan Specifying Priority Projects and Detailing Approaches to Attract Investment**

1. **Northeast Asia energy market specialist and team leader** (international, 6 person-months). The expert should have a postgraduate degree or equivalent in economics, public policy administration, and/or engineering with over 15 years of international professional experience in energy sector planning, energy economics, energy policy, and/or energy market modelling. The expert must have good knowledge of energy sector assessment, including technical, financial, economic, and institutional assessment of country-specific and regional energy markets. Experiences in Mongolia's energy sector and/or Northeast Asian energy markets would be an advantage. The expert will (i) serve as team leader and ensure quality control and punctual delivery of consultants' tasks and deliverables; (ii) provide detailed guidance and supervision to international and national energy market researchers in research design and execution; (iii) review existing studies and initiatives related to (a) power interconnection in Northeast Asia,¹ and (b) similar situations involving a power connection between a small country and larger neighbors for electricity export (i.e., Bhutan and Paraguay), and identify successes, failures, and lessons; (iv) assess current power markets in Northeast Asia, taking into consideration the power system interconnection; the assessment should at least (a) provide an overview of each power market in the subregion;² (b) describe provisions of power infrastructure, energy sources for power, technologies for power generation, scales of power supply and demand, power trade, and institutional frameworks of each power market, including types of power suppliers and general legal frameworks ruling each power market; (c) identify existing demand, including unmet demand, and produce 20-year growth country projections for high, low, and base-case growth scenarios for each power market; (d) discuss historic and projected electricity prices at different markets; (e) identify information gaps and assumptions for market assessment; and (f) gather other relevant information on unique characteristics of the Northeast Asian power markets; (v) develop various scenarios for power trade and grid integration in Northeast Asia and discuss associated impacts, both positive and negative, at different levels of power integration in the subregion; (vi) propose the most optimized regional interconnection plan for Northeast Asia; (vii) identify the benefits of a regional interconnection plan for Northeast Asia, compared with planning on a national basis and quantify economic, financial, environmental, and social benefits, including in terms of reduced greenhouse gases emissions; (viii) assess scales of investment reflecting different scenarios of grid integration; (ix) analyze specific subregional barriers in detail, considering the lessons from other existing subregional and regional grid systems; (x) discuss the role of Mongolia in detail for Northeast Asia power integration and interconnection; (xi) prepare a comprehensive background report on energy markets and future Northeast Asia power interconnection; (xii) propose and recommend key experts, groups, and institutions and support the formulation of the Northeast Asia Power System Interconnection (NAPSI) steering committee; (xiii) analyze system technical requirements for the interconnected network in Northeast Asia and define

¹ Studies such as ADB. 2002. *Technical Assistance Completion Report: Strategic Study on Development Options for Economic Cooperation between Mongolia and the People's Republic of China (PRC) in the Eastern Parts of Inner Mongolia Autonomous Region, PRC and Mongolia*. Manila. and ADB. 2009. *Development of Regional Cooperation Programs for Mongolia and the People's Republic of China*. Consultant's report. Manila, and Initiatives such as the Greater Tumen Initiative. <http://www.tumenprogramme.org/>.

² Power sector information can be available at: <http://www.enecho.meti.go.jp/en/> for Japan, <http://en.energy.gov.mn/> for Mongolia, <http://english.cec.org.cn/> for the People's Republic of China, and http://www.keei.re.kr/main.nsf/index_en.html for the Republic of Korea.

technical actions required for Mongolia to connect to other countries; (xiv) actively participate in the NAPSI steering committee, facilitate discussions, and play a leading role in developing a consensus-based road map for Northeast Asia power interconnection; (xv) review and assess planned country and regional interconnection projects and propose new projects as appropriate; (xvi) draft the Northeast Asia power interconnection road map, fully incorporating discussion, opinions, and comments from the NAPSI steering committee, the executing and implementing agencies, and the Asian Development Bank (ADB); (xvii) develop short-, medium- and long-term investment mechanisms reflecting the Northeast Asia power interconnection road map, and incorporating comments from the NAPSI steering committee; (xviii) develop an action plan for Mongolia, incorporating comments from the NAPSI steering committee based on the Northeast Asia power interconnection road map, and identifying priority projects with a specific investment and business plan; and (xix) plan and lead capacity building activities, including consultations, workshops, conferences.

2. **Energy economist** (international, 3.2 person-months). The expert should have a postgraduate degree or equivalent in economics with over 15 years of international professional experience in energy sector planning, energy economics, and energy modelling. Experience in Mongolia's energy sector and/or Northeast Asia energy markets would be an advantage. The expert will (i) assess current electricity load demand (load profile, including peak power) and develop a load demand projection and profile for countries in Northeast Asia for 2017–2036; (ii) develop different power demand and supply scenarios including a low-carbon case, least-cost case, and others under different plausible future energy market scenarios (in terms of fuel price, carbon price, and changes in renewable energy costs); (iii) assess electricity export and import volumes in Northeast Asia for 2017–2036; (iv) develop evaluation criteria to rank and weigh different scenarios; (v) conduct power supply optimization simulations based on the criteria; (vi) carry out an analysis of a subregional power supply tariff, including capacity payment (fixed cost recovery), energy payment (variable cost recovery), and transmission tariffs in cooperation with the team leader, transmission engineer, and the power engineer; and (vii) review and assess planned country and regional interconnection projects and propose new projects as appropriate.

3. **Transmission engineer** (international, 5 person-months). The expert should have a postgraduate degree or equivalent in electrical engineering with over 10 years of international professional experience in energy sector planning, power infrastructure, and/or grid system analysis. The expert must have good knowledge of grid system engineering, transmission technologies, and associated cost implications of transmission line infrastructure. The expert will (i) assess the current condition of transmission assets in Northeast Asia and identify transmission capacity and adequacy, taking into consideration subregional power system interconnection; (ii) carry out a megavolt-ampere capacity transfer assessment for transmission line capacity, voltage selection, and transfer limits of subregional power system interconnection based on forecasts of electricity import and export volumes for 2017–2036 provided by the energy economist; (iii) prepare indicative investment plans, including transmission line and associated facilities for 2017–2036; and (iv) assess current grid codes (ancillary, frequency, and voltage control) in countries in Northeast Asia, and identify constraints, opportunities, and suggestions to develop a plausible common grid code for power system interconnection, in case high-voltage direct current transmission lines is an appropriate solution for grid interconnection.

B. Output 3: Analysis of Mongolia's Renewable Energy Capacity Expansion Plan to Export Clean Electricity

4. **Northeast Asia energy market specialist and team leader** (international, 1 person-month). The expert should have a postgraduate degree or equivalent in economics, public

policy administration, and/or engineering with over 15 years of international professional experience in energy sector planning, energy economics, energy policy, and/or energy market modelling. The expert must have good knowledge of energy sector assessment, including technical, financial, economic, and institutional assessments of country-specific and regional energy markets. Experience in Mongolia's energy sector and/or Northeast Asia energy markets would be an advantage. Together with the tasks indicated in para. 2, the expert will (i) review existing Mongolian laws and regulations relevant to the energy sector and power export and assess potential legal and regulatory bottlenecks for promoting the power trade; (ii) review current power trade practices and contracts between Mongolia and neighboring countries, and assess them for improvement, considering expansion to a full-scale power trade; (iii) recommend necessary financial and nonfinancial government support to increase renewable energy for power trade expansion; and (iv) prepare a policy note on legal and regulatory improvements for power trade expansion.

5. **Transmission engineer** (international, 2 person-months). The expert should have a postgraduate degree or equivalent in electrical engineering with over 10 years of international professional experience in energy sector planning, power infrastructure, and/or grid system analysis. The expert must have good knowledge of grid system engineering, transmission technologies, and associated cost implications of transmission line infrastructure. Together with the tasks indicated in para. 4, the expert will (i) review long-term investment cost estimates for transmission line and associated facility refurbishment in the Updating Energy Sector Development Plan (UESDP) technical assistance final report³ and assess the current status of transmission lines and associated facilities, and update cost estimates; and (ii) review Mongolia's power system integration plan proposed in the UESDP technical assistance final report, reassess these integration proposals in the context of interconnection with neighboring countries, and propose a revised integration plan if needed.

6. **Renewable energy resource assessment specialist** (international, 4 person-months). The expert should have a postgraduate degree or equivalent in engineering and/or meteorology with over 10 years of international professional experience in solar and wind resource assessment. Experience in Mongolia and/or Northeast Asia countries would be an advantage. The expert will (i) review outputs of resource assessments conducted under the UESDP, (footnote 2) and Investment Plan for Scaling Up Renewable Energy in Mongolia;⁴ (ii) acquire and assess satellite imagery and meteorological station datasets on solar irradiation (global horizontal and direct normal irradiation) and wind resource (wind speed and rose) for 2017–2026 to identify suitable areas for large scale solar (photovoltaic and concentrated solar thermal) and wind power generation, and prepare solar and wind resource potential maps; and (iii) carry out detailed solar and wind resource assessments together with probability analysis, and collaborate with the international transmission engineer, international energy economist, and international power engineer on (a) selection of power plant sites, transmission alignments, and renewable energy technologies; and (b) levelized cost of electricity analysis.

7. **Energy economist** (international, 1.8 person-months). The expert should have a postgraduate degree or equivalent in economics with over 15 years of international professional experience in energy sector planning, energy economics, and energy modelling. Experience in Mongolia's energy sector and/or Northeast Asia energy markets would be an advantage. The expert will (i) conduct research and analysis on primary energy (e.g., coal, oil, natural gas, and

³ ADB. 2013. *Updating the Energy Sector Development Plan*. Consultant's report. Manila (TA 7619-MON).

⁴ ADB. 2014. *Technical Assistance to Mongolia for the Preparation of an Investment Plan for Scaling Up Renewable Energy*. Manila.

renewable) and power generation technologies, calculating the levelized cost of electricity in Mongolia; (ii) prepare a candidate list of power plants in Mongolia that will be needed for power export for 2017–2036, and develop selection criteria to rank and weigh different scenarios; and (iii) conduct a power supply optimization simulation based on the criteria, prepare a planting schedule, and prepare Mongolia power capacity addition plan for power export in 2017–2036.

8. **Power engineer** (international, 4 person-months). The expert should have a postgraduate degree or equivalent in engineering with over 10 years of international professional experience in power sector planning, power engineering, and/or grid system analysis. The expert must have a good knowledge of grid system engineering, transmission technologies, and associated cost implications of transmission lines infrastructure. The expert will prepare indicative capacity addition plans for Mongolia power generation, taking into account power export, under a Northeast Asia power system interconnection scenario. These plans shall include (i) assessment of capacity of power generation technology, (ii) planting (location of power plants in a view of least-cost options), and (iii) planting schedule for Mongolia to meet necessary load demand in Northeast Asia for 2017–2036.

9. **Mongolia energy market researcher** (national, 10 person-months). The expert should have a postgraduate degree or equivalent in economics, public policy and policy administration, and/or engineering with over 10 years of professional experience in Mongolia’s energy sector, energy economics, energy policy, and/or energy market assessment. Experience in energy modelling would be an advantage. The expert will (i) research Mongolia’s current power market, taking into consideration Northeast Asia power interconnection; the research shall, at least (a) provide an overview of Mongolia’s power market; (b) describe provisions of power infrastructure, energy sources for power, power generation technologies, scales of power supply and demand, power trade, and institutional frameworks of each power market, including types of power suppliers and general legal frameworks in the Mongolia power market; (c) discuss historic and projected electricity prices at Mongolia markets; (d) identify information gaps and assumptions for market assessment; and (e) gather other relevant information on unique characteristics of Mongolia in relation to a future Northeast Asia power interconnection; (ii) support the team leader in developing various scenarios of power trade and grid integration in Northeast Asia; (iii) support the team leader in assessing different grid integration scenarios and related investments; (iv) draft sections on Mongolia’s power market for a comprehensive background report on Northeast energy markets and future Northeast Asia power interconnection; (v) provide relevant detailed information on the role Mongolia can play in subregional power integration and Northeast Asia power interconnection; (vi) propose and recommend key experts, groups, and institutions in Mongolia and support formulation of the NAPS steering committee; (vii) support the team leader in drafting the Northeast Asia power interconnection road map; (viii) support the team leader in developing an action plan for Mongolia by providing potential project ideas and associated detailed investment costs, based on the Northeast Asia power interconnection road map; and (ix) plan and lead capacity building activities, including consultations, workshops, and conferences.

10. **Power engineer** (national, 5 person-months). The expert should have a postgraduate degree or equivalent in electrical engineering with over 10 years of experience in power sector planning, power engineering, and/or grid system analysis. The expert will undertake activities supporting the international power engineer (para. 8).

11. **Transmission engineer** (national, 5 person-months). The expert should have a postgraduate degree or equivalent in electrical engineering with over 10 years of professional

experience in energy sector assessment, power infrastructure, and/or grid system analysis. The expert will undertake activities supporting the international transmission engineer (para. 5).

12. **Energy economist** (national, 5 person-months). The expert should have a postgraduate degree or equivalent in economics with over 5 years of professional experience in energy sector assessment, energy economics, and energy modelling. The expert will undertake activities supporting the international energy economist (para. 7).

13. **Renewable energy resource assessment specialist** (national, 5 person-months). The expert should have a postgraduate degree or equivalent in engineering and/or meteorology with over 5 years of professional experience in solar and/or wind resource assessment in Mongolia. The expert will undertake activities supporting the international renewable energy resource assessment specialist (para. 6).

C. Output 4: Knowledge Sharing and Consensus Building for the Northeast Asia Power System Interconnection and Output 5: Initiation of a Regional Knowledge and Investment Platform for the Northeast Asia Power System Interconnection

14. **Country coordinators for the Northeast Asia Power System Interconnection Steering Committee** (3 international, 5 person-months each; 1 national, 10 person-months). The experts should have a postgraduate degree or equivalent in economics, public policy administration, international affairs, and/or engineering. The experts shall have over 10 years of international professional experience in subregional, regional, and international cooperation in energy. The experts must have good communication skills in English, good interpersonal and networking skills, and have good knowledge of the energy sector. The experts will (i) participate in the NAPSI steering committee as country coordinators; (ii) work closely with the executing and implementing agencies, ADB, and members of the NAPSI steering committee; (iii) propose and recommend key experts, groups, and institutions in the designated countries who can be steering committee members; (iv) maintain regular and close contact with designated steering committee members; (v) propose capacity-building activities that could support the realization of the steering committee; (vi) organize consultations, workshops, conferences, and other events, including preparing agendas, inviting speakers and panelists, managing logistics, publishing minutes or proceedings, undertaking financial management of those activities, and other activities relevant to event coordination; and (vii) prepare and provide semiannual progress reports on his or her activities, and reports on each conference and/or workshop held.

15. **Reporting requirements.** The consultants for outputs 1, 2, and 3 will submit the following reports to ADB (in English) and to the government (in Mongolian):

Table A3: Reporting Requirements

Name of report		Deadline
1.	Inception report for outputs 1, 2, and 3	Within 1 month of commencement of services
2.	Interim report for outputs 1 and 3	Within 5 months of commencement of services
3.	Draft final report for outputs 1 and 3	Within 9 months of commencement of services
4.	Interim report for output 2	Within 14 months of commencement of services
5.	Draft final report for output 2	Within 17 months of commencement of services
6.	Final report for outputs 1, 2, and 3	Within 25 months of commencement of services