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MONGOLIA VISION 2050

A ROADMAP TO BECOMING A SELF-SUFFICIENT CLEAN ENERGY EXPORTER

MONGOLIA ENERGY GOVERNANCE (MEG) ACTIVITY
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CONTENTS

ACRONYMS

Abt	Abt Associates Inc.
ADB	Asian Development Bank
BESS	Battery Energy Storage Systems
CAPEX	Capital Expenditure
CBM	Coalbed Methane
CHPs	Combined Heat and Power Plant
CO2	Carbon Dioxide
DSM	Demand Side Management
ERC	Energy Regulatory Commission
ERP	Energy Revival Policy
ESCO	Energy Service Companies
ESS	Energy Storage Systems
EV	Electric Vehicle
FiT	Feed in Tariff
GHG	Greenhouse Gases
GOM	Government of Mongolia
HV	High Voltage
HPP	Hydro Power Plant
IRENA	International Renewable Energy Agency
IRRP	Integrated Resource Resilience Plan
LED	Light-Emitting Diodes
MEPS	Minimum Energy Performance Standard
MW	Megawatt
NAPSI	Northeast Asia Regional Power System Interconnection
NDC	National Dispatching Center
NRP	New Revival Policy
OPEX	Operating Expenses
OT	Oyu Tolgoi
PP	Power Plant
PPA	Power Purchase Agreements
PPP	Private Public Partnership
RE	Renewable Energy
SCADA	Supervisory Control and Data Acquisition System
SLCPs	Short Lived Climate Pollutants
SOE	State Owned Enterprise
UB	Ulaanbaatar
USAID	United States Agency for International Development
USD	United States Dollar
WHO	World Health Organization

EXECUTIVE SUMMARY

This document was prepared and submitted by the USAID Mongolia Energy Governance (MEG) Activity implemented by Abt Associates. This roadmap provides incremental steps to modernize Mongolia's power sector by expanding and operationalizing energy goals laid out in 'Vision-2050', the long-term national development policy for Mongolia which covers energy, environment, quality of life, human development, economy, and other areas of national development priority. General and specific recommendations are laid out under four major pillars: Improving Legal Framework; Defining Optimum Energy Market Structure; Adopt Demand-Side Management Best Practices; Optimizing Energy Mix.

Each recommendation in the roadmap is aligned with three major milestones laid out in Vision-2050: Energy Self-Sufficient Mongolia, Energy Exporter Mongolia, and Land of Clean Energy.

By 2030, Mongolia aims to become energy self-sufficient. By 2040, Mongolia would like to then export clean energy to neighboring countries in the region. Having achieved these important milestones, the country hopes to increase green energy production and ensure sustainable energy supply to the region by 2050. Specific activities stipulated in Vision-2050 have been included for ease of reference.

Vision-2050 provides insights on how Mongolia can accelerate its efforts to strategically advance Mongolia's energy transition and overcome existing technical, political, economic, and environmental challenges. The roadmap communicates a clear and accessible vision of the transformation of the Mongolian energy sector, with special focus on supporting sustainable change in policy and regulatory frameworks to adopt innovative technologies and to create a fair and competitive environment for the private sector.

Access to affordable, reliable, and modern energy services is critical to reduce Mongolia's carbon footprint, lower GHG emissions and toxic air pollutants from the energy sector, and contribute to global climate action.

Through greater coordination between government and institutions, the private sector, development partners and civil society organizations, a rapid, transparent, inclusive, and sustainable transition to a better energy future is possible for Mongolia.

SWOT ANALYSIS OF THE ENERGY SECTOR OF MONGOLIA

STRENGTHS

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- Energy resources available to generate energy (Coal, wind, solar, hydro and others)
- Increasing national demand for electricity and heating
- Geological/natural condition for wind and solar infrastructure projects
- Low-cost land and resource acquisition
- Close location to the largest energy consuming country
- Relatively small system with highly concentrated users

WEAKNESSES

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- Lack of transparency in policy and regulatory environment
- Political-driven, short sighted, and inadequate planning and decision making
- Limited access to financial resources for new capacity and infrastructure projects
- Poor governance of state-owned companies
- Inefficient tariff rate and mechanism for investment in the energy sector
- Outdated energy systems

  Immature and closed energy market, and the weak accountability system
- Lack of skilled human resources for energy transition
- Limited access to alternate fuels and regional cross-border trade

OPPORTUNITIES

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- Improved operational measures for utilities, grid operators, and generators
- Restructuring of energy sector institutions
- Potential to encourage competition, private sector investment, and efficiency throughout the energy value chain
- Regional power interconnectivity initiatives
- Deployment of utility-scale renewable energy project through competitive procurement mechanism
- Development of distributed renewable energy systems and energy efficiency
- Promising potentials for CBM and Hydrogen technologies

THREATS

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- Strong political influence
- Dependence on coal-based electricity and heat generation leaves Mongolia vulnerable to climate change-related policies and actions
- Foreign exchange shortage or depreciation affect reliable supply of equipment and devices for the energy companies
- Investment-related disputes in the past increase foreign investment cost as investors require the Government more guarantees
- Overdependence of energy sector investment on one country
- Low awareness of public and politicians on long-term benefits of clean energy technologies

ROADMAP FOR MONGOLIA: IMPLEMENTATION MILESTONES

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Sainshand wind park, 55 MW,
Dornogobi aimag, Mongolia.

1 ROADMAP FOR MONGOLIA: IMPLEMENTATION MILESTONES

> *The roadmap is built on three key implementation milestones of Vision-2050 that are defined through three strategic phases.*

IMPLEMENTATION MILESTONE 1: ENERGY SELF-SUFFICIENT MONGOLIA (2022 – 2030)

Mongolia aims to become energy self-sufficient and minimize its dependence on energy imports by 2030. The country is also working strategically to introduce clean and modern technologies to accelerate energy transition and invest in sustainable energy infrastructure, supported by long-term integrated energy planning strategies. Implementation milestone I involves shifting investment to variable renewables from conventional energy, along with a comprehensive policy package that gradually phases out fossil fuel subsidies.

Through its international commitment to the Paris Agreement to reduce GHG emissions, Mongolia seeks feasible, innovative, and sustainable solutions to invest in renewables, energy efficiency, upgraded power grids, and more. Modern technologies, including ultra-supercritical boilers for existing and new plants, and systematic energy demand response - including improved performance of energy companies and green building standards - will help the country to improve its energy security and promote sustainable growth.

In the short term, adding power capacity through conventional energy projects is inevitable to meet the growing energy demand of the nation. While investments and modern technologies are badly needed in the sector to overcome the energy capacity shortage, under the current tariff structure new investments are difficult to implement. A structured energy tariff that fully covers costs and supports energy saving and new advanced technologies would generate new investment and support the implementation of new technologies and investments.

The first step for Mongolia toward becoming energy self-sufficient is to bring energy prices to a cost-recovery level. Over the past 30 years, the Mongolian government has kept electricity and heat tariffs under strict control, preventing the energy sector from carrying out necessary maintenance, repair and renovation on its generators and transmission and distribution networks. Currently, the sector is unable to meet growing energy consumption needs, leading to curtailed electricity and heat during cold winter months.

In order to implement projects and programs for the development of the energy sector, and to ensure its economic sustainability and viability, the Energy Regulatory Commission (ERC) conducted a study on the tariff change forecast by considering the above-mentioned objectives. Outcomes of the study suggest increasing the annual base of the electricity tariff step by step to 12.2 US cents per kWh by 2030[1].

To increase the energy security of Mongolia, MEG recommends establishing a high-capacity interconnection with the Inner-Mongolian power grid. One solution is to introduce a back-to-back DC coupling station in the southern Gobi-border region. This will not only increase national energy security but also open doors for a full-scale supply of Oyu Tolgoi (OT) mining as a reliable energy source from the Mongolian energy system. Introducing the coupling station could also act as a cornerstone to enable regional power trade projects such as the Northeast Asia Regional Power System Interconnection (NAPSI).

Mongolia today faces an energy challenge that has become an ever-worsening public health crisis. Ulaanbaatar is the coldest capital city in the world, and demand for electricity for heating far outstrips supply, forcing residents to burn cheap and dirty coal in the frigid winters and contributing to some of the world's worst air quality and poor health outcomes, particularly for women and children.

An integrated policy package to introduce and pilot innovative heating solutions for ger (peri-urban residential) areas is instrumental to improving public health and welfare. One of

1 ERC (2022), Study on Energy Tariff presented to the Cabinet

the development targets of urban settlements is to reduce air pollution associated with coal-briquette fueled heating, where the MEG project recommends establishing an incentive mechanism for heat efficiency measures focused on integrating renewables for clean heating such as gas, ground source heat, solar, and efficient heat pumps.

Additionally, capacity building and training of skilled energy practitioners, as well as the fostering an enabling environment to promote public-private partnerships and unlock access to governmental financial resources will be instrumental in this phase.

IMPLEMENTATION MILESTONE 2: ENERGY EXPORTER MONGOLIA (2031 – 2040)

Energy capacity additions will help Mongolia to become a clean energy exporter in the Northeast Asian region. Large scale penetration of clean energy technologies alongside the adoption of carbon absorption measures could lead to the reduction of national greenhouse gas emissions to reach new global climate change agreement targets.

The Mongolian Government has supported and initiated activities through the NAPSI project, enabling power trade between regional countries such as China, Japan, Russia, and South Korea. Multilateral cooperation throughout the region could help Mongolia better utilize its vast renewable and non-renewable energy resources. Findings from an initial study from the NAPSI project demonstrate that it is possible to interconnect 5GW of Mongolian wind and solar energy capacity to the regional power system by 2026. Second and third phases of the could interconnect 10GW by 2036 and 100GW beyond 2036.

Renewable energy (RE) sources and load centers are scattered throughout the country, requiring the construction of overhead power transmission lines, sub-stations, and new power generating sources along the existing lines to form an integrated national power system. Renewable energy is available intermittently, requiring upgraded load capacity along with modern energy storing technologies to be added to the power system. Short and long-term storage solutions are an important facet and will add flexibility to the grid.

Public-private partnerships also play a critical role in: (1) financing the introduction of innovations, technologies, and knowledge-sharing; (2) promoting the production of export-oriented products and services and supporting access to export markets; and (3) creating an opportunity for micro, small, and medium businesses to compete on the world market.

Evaluating the number of jobs that could be created by introducing clean energy systems, but which will also be lost from the conventional energy sector, will be a crucial aspect of this phase, with an emphasis on minimizing disruptions to individuals and communities. To meet expected increase of demand for skillful energy practitioners, higher educational institutions will need to meet international standards and the quality of national research universities with internationally graded and recognized curriculum must also increase.

IMPLEMENTATION MILESTONE 3: LAND OF CLEAN ENERGY (2041 – 2050)

To meet net-zero commitments as part of the Paris Agreement, Mongolia must also continue setting long-term and more ambitious targets to reduce greenhouse gas and toxic emissions. Public policies and investment decisions need to be well-aligned with climate and sustainable development goals to achieve these targets.

Energy efficiency and renewable energy are the two main pillars to enable successful energy transition. Viable business models to introduce and scale-up the use of green hydrogen as well as renewables-based electrification with optimum carbon management could be important to lower air pollution and achieve better health across the country.

Transition from conventional systems to advanced, independent, and integrated energy systems equipped with digitalization and smart meters would support Mongolia's efforts in achieving ambitious climate goals. Mongolia must take a strategic approach to increasing the share of renewables in the energy mix and becoming a clean energy exporter in the region. The electrification of heating and transportation sectors in the country will play a significant role to achieve the GHG reduction targets.

Tapping into potential investment platforms from international partners would help the country unlock the financial resources needed to achieve clean energy transition. Developing strategic relationships abroad and maintaining successful power sales with multiple parties will require a strong and transparent regulatory framework and commonsense legislation. Strengthened collaboration and partnership between the private sector and the government can help combat climate change, create jobs, and forge a cleaner energy future.

VISION-2050 AND THE MONGOLIAN ENERGY SECTOR

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Sumber solar power plant, 10 MW,
Gobisumber aimag, Mongolia.

2 VISION-2050 AND THE MONGOLIAN ENERGY SECTOR

Монгол Улсын Үндсэн Хуульд хөгжлийн бодлого, төлөвлөлт нь цогц, урт хугацааны тогтвортой байна гэж заасан байдаг. МУЗГ нь “Хөгжлийн бодлого, төлөвлөлт түүний удирдлагын тухай” хуулийг 2020 онд шинэчлэн найруулж, урт хугацааны бодлогыг 30 жил, хөгжлийн дэд хөтөлбөрүүдийг 10 хүртэл жил, мөн 2021 оноос эхэлсэн үндэсний хөрөнгө оруулалтын хөтөлбөрийг таван жилээр тус тус боловсруулж хэрэгжүүлэхээр батлсан.

Exhibit 1: Overview of Development Policy and Planning Framework

Source: *Mongolia Today, 2020*

Vision-2050 was adopted in 2020 and lays out six priority economic sectors for investment and development focus over the course of 30 years, including the energy sector:

- Value-added mining and related infrastructure megaprojects
- Processing industry
- Energy sector
- Transport and logistics
- Tourism and related services
- Knowledgeable and productive sectors

In addition, Vision-2050 lays out six goals with specifically stated objectives to advance energy transition in Mongolia:

- Human Development to groom a healthy, socially active Mongolian through creation of an enabling environment where everyone leads a happy life enjoying social protection as an assurance of quality life and having access to quality education - the foundation for the country’s development and a secure family life **(Goal 2)**.
- Quality of Life and Middle Class to Sustainably increase family income by promoting employment, cultivate active and creative families with adequate housing, develop middle class able to run competitive micro, small, and medium businesses in an enabling investment environment and capable of sustaining their families; and supported with satisfying living conditions **(Goal 3)**.
- Become a nation with sustainable economic growth beneficial to all, predominant middle class and substantially reduced poverty, a solid economic development policy base and self-sufficient in meeting domestic needs, increased export, enhanced capacity in investment and savings, and multi-pillared economy **(Goal 4)**.
- Green Development to promote an environmentally friendly green development, maintain balance of ecosystem, ensure an environmental sustainability, create conditions for present and future generations to reap its benefits, and improve the quality of human life (Goal 6).
- Regional and economic development to pursue a competitive and well-balanced regional and local development, aligned into the regional economic integration, through respect for national culture, sustainable settlements, preserved nature and eco-balance to be inherited by future generations, and the coherent green production with combined economic diversification and specialization **(Goal 8)**.
- Develop a comfortable, environmentally friendly, people-centered and smart city **(Goal 9)**.

Vision-2050 also sets three implementation phases to achieve sustainable energy transition by 2050.

Exhibit 2: Vision-2050 objectives related to the energy sector by their implementation phase

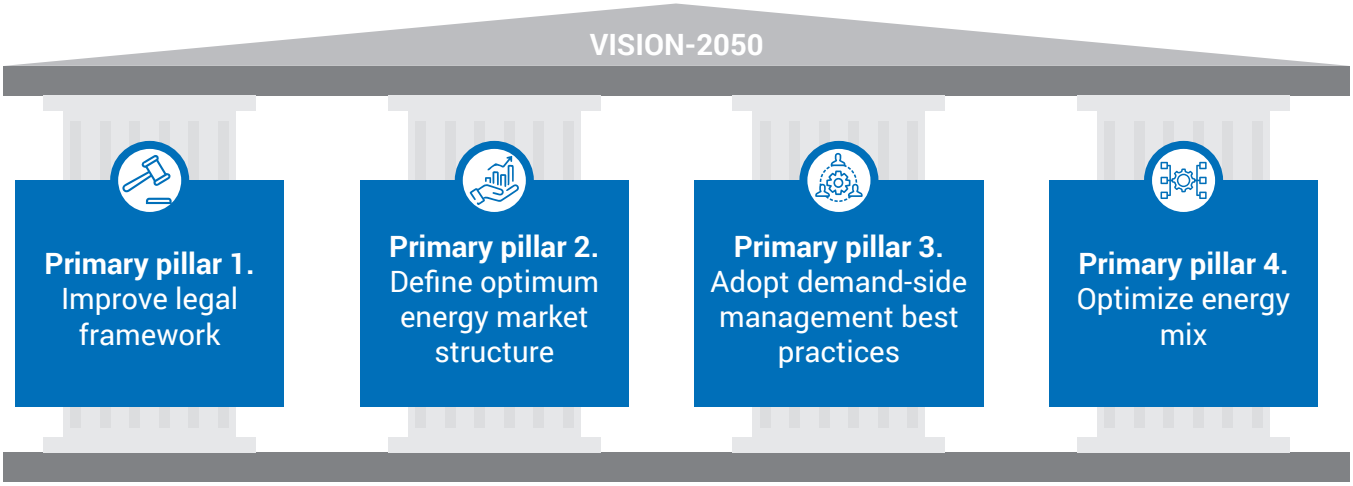
	2021 - 2030	2031 - 2040	2041 - 2050
Human development	Reduce air, water and soil pollution and noise level and create a clean and green environment. Train skilled workers in line with labor needs and market demands of large agricultural, industrial and infrastructure projects, and develop professional education and training activities for graduates to create their own job opportunities.	Increase the number of higher education institutions meeting international standards and improve the quality of national research universities with internationally graded and recognized curriculum.	Completely remove the negative impact on human health and the economy caused by environmental pollution, and create a comfortable eco-environment in cities, soums and settlements with parking lots, green areas, swimming pools, and sporting spaces for residents to relax and spend their leisure time.
Quality of Life and Middle Class	Enhance an enabling environment for micro, small, and medium businesses	Improve the conditions of ger district by increasing access to and provision of affordable, and quality green housing that conform to the purchasing power of the population. Develop public-private partnerships for financing the introduction of innovations, technologies and knowledge-sharing, promote the production of export-oriented products and services, and support their access to export markets, and create an opportunity for micro, small, and medium businesses to compete on world market.	
Economy	Develop energy and engineering infrastructure to support economic development. Expand power plants, construct electricity transmission lines, sub-stations and new energy sources and become self-sufficient in electricity production.	Construct overhead power transmission lines, sub-stations and new sources of energy for main horizontal and regional vertical axes, expand some thermal power plants and build an integrated energy system. Increase export-oriented sources and become energy exporter.	
Green Development	Reduce greenhouse gas emissions and increase carbon absorption in energy, agriculture, construction, transport, industry, and waste management sectors. Support and develop a national green financing system based on public-private partnership, and finance environmentally friendly green projects and programs using international financial instruments.		Reduce national greenhouse gas emissions and increase carbon absorption within the new Climate Change Agreement.
Regional and economic development	Develop the independent integrated energy system, shift to a smart system for the mixed use of renewable energy sources and become an energy exporter.		
Ulaanbaatar and satellite cities	Develop a comfortable, environmentally friendly, people-centered and smart city. Reduce air, soil and environmental pollution and pollutants by introducing environmentally friendly and advanced knowledge and technologies. Increase capacity of the engineering infrastructure and introduce modern technologies. Introducing and implementing green building standards.	Transfer energy consumption of ger area and green zone households to renewable energy sources and provide opportunities to supply electricity generated by households to the central grid.	Fully introduce smart and green technology in creating comfortable and healthy living environment Increase green energy production and ensure sustainable energy supply to the region.

3 THE ROADMAP: FOUR PILLARS

Sainshand wind park, 55 MW, Dornogobi aimag, Mongolia.

THE ROADMAP: FOUR PILLARS 3

This roadmap provides incremental steps to modernize the power sector with advanced energy technologies by expanding and operationalizing Vision-2050. General and specific recommendations are categorized by four primary pillars: (1) Improving legal framework; (2) define optimum energy market structure; (3) adopt demand-side management best practices and (4) optimize energy mix.



PILLAR 1: IMPROVE LEGAL FRAMEWORK

VISION-2050 LEGAL FRAMEWORK OBJECTIVES FOR ENERGY

This section presents the current policy and regulatory environment in Mongolia, the introduction of major laws of the energy sector, and recommendations by implementation phase as laid out in Vision-2050.

Vision-2050 Activities

3.2.12. Create a sustained system of policy and financial support for introducing green housing.

4.1.27. Elaborate and implement the national policies and programs to increase foreign direct investments, create an enabling environment, and promote supplies.

4.1.30. Draft and implement a law supporting private sector investment initiatives.

4.1.31. Renew and implement the policy on the partnership between the state and private sector in line with international standards.

4.5.2. Improve the legal regulation of activities within the state-private sector partnership on the introduction of innovation and technology and sharing knowledge.

6.4.7. Implement the Paris Agreement, ensure the implementation of Mongolia's contribution through the NDC, develop renewable energy, and reduce greenhouse gas emissions in the energy, agriculture, construction, transport, industry and waste management sectors.

Source: Vision-2050, the long-term national development policy for Mongolia.

BACKGROUND

It has been almost 20 years since fundamental policy and structural reforms in the energy sector were introduced in Mongolia through the newly revised Energy Law of Mongolia in 2001. Following this reform, the energy sector has built stronger market relationships, been more heavily regulated, and has encouraged greater private sector participation and investment. The sector is structurally divided into production, transmission, and distribution and supply, with each regulated through special licenses, ensuring the financial and economic stability of the industry and license holders.

Within the country's legal framework, the energy sector continues to operate normally and provides consumers with electricity and heat energy. However, the main drivers of the sector's long-term sustainable and growth development, such as regulated and competition-based market principles, investment supporting the private sector, new capacity, and technical and technological innovation, are not well-supported.

LAW ON ENERGY

The Energy Law of Mongolia is the primary governing law of the energy sector, regulating all energy generation, transmission, distribution, dispatching, supply, construction of energy facilities, and energy consumption using energy resources. Principle changes introduced during the revision of the Energy Law were: (1) the creation of legal entities or companies by unbundling the centralized structure of the energy sector; (2) issuing special licenses; and (3) establishment of the ERC to regulate the sector through license and tariff regulations. The law regulates supply of electricity, heat, and gas supply throughout integrated energy systems in Mongolia.

LAW ON RENEWABLE ENERGY

The Law on Renewable Energy of Mongolia was adopted in 2007. It regulates all activity related to the production and supply of energy using RE sources and supports the development of renewable energy. To support RE technologies – which were more expensive at the time the law was introduced - the Feed-In Tariff (FiT) mechanism was chosen to attract foreign investment and to create guarantees and to set maximum and minimum tariffs for electricity purchased from renewable energy projects in the integrated grid, measured in US cents and reflected in the law. For example, solar energy costs 15-18 USD cents, and wind energy costs 8-9.5 USD cents per kWh respectively.

In 2015, the "Support Tariff" as a renewable energy levy was introduced into the law to compensate for the difference in RE tariffs, resulting in a certain number of additional payments for electricity consumers. This tariff system has yielded results and was the prime condition for investing in 271.2 MW plants that are in operation today. As the cost of solar and wind energy technology has decreased in the world market for the last decade and reached a level whereby RE technology is able to compete with traditional energy without subsidies, the FiT mechanism has been changed and the principle of setting tariffs based on competition was introduced into the law in June 2019. In this way, solar and wind power projects can be implemented without any additional tariff burden on end consumers,

LAW ON ENERGY CONSERVATION

In 2015, the Law on Energy Conservation was approved, promoting the efficient use of energy and more efficient equipment and technologies for both energy suppliers and consumers. In Mongolia, outdated Combined Heat and Power Plants (CHPs), constructed in the 1980s, are the country's primary energy source. The law contains regulations aimed at the implementation of energy saving and efficiency activities, personnel training, and supporting enterprises that use high density electricity and heat to reduce their energy consumption. Since the adoption of the law, 114 energy auditors, 314 energy managers, 14 audit organizations, and four Energy Service Companies (ESCO) have been established, and the government has provided support and advice to large energy users and 197 designated consumers whose electricity consumption exceeded over the limit set by the Government. The main implementing body of the law is the ERC.

IMPLEMENTATION MILESTONE 1: ENERGY SELF-SUFFICIENT MONGOLIA (2022–2030)

Review relevant policy, laws and regulations, including investment, bankruptcy, customs, tax, development, digitalization, etc., and revise where needed. Reviewing and improving new and existing market rules and regulations related to the operation of the energy sector based on market principles is a primary focal area, as is fostering a friendly environment where energy companies are treated in equally, transparently,

and fairly around their technical and financial operation.

Digital solutions in core infrastructure development such as smart meters are integrated into national energy strategies and development plans are prioritized. Mongolia's long power transmission lines that cover vast territory are vulnerable to grid stability risks. The electricity management system of the country was commissioned in 2006 and has limited capability to dispatch energy efficiently or manage financial expectations and activities between power supply entities (power generation, transmission, and distribution companies) and consumers. The supervisory control and data acquisition (SCADA) system - used for grid monitoring and control - covers a limited number of substations and is segmented by region (ADB, 2019). Central and local authorities and grid operators would benefit from interoperable and open source digital systems when possible.

Digitalizing the national power system also involves the development of small-scale, distributed power systems, determining the optimal location of distributed sources, and allowing system operators to monitor and coordinate operations remotely, ensuring the security, reliability, and flexibility of the power system.

Planning, financing, technology, innovation, and cybersecurity are part of Mongolia's digital energy transition. The Government of Mongolia has established Ministry of Digital Development and Communications as one of the country's key goals in achieving Vision-2050.

Energy policy should consider all available energy resources in comprehensive long-term energy planning and implement them according to detailed action plans, ensuring that legal and governmental institutions are progressing in order to embrace all available energy resources.

Develop and adopt Mongolia's Integrated Resource Resilience plan (IRRP), especially by establishing early ownership by the Government of Mongolia, providing a clear pathway for key stakeholder collaboration, establishing a process for data collection and improvement, and tailoring the IRRP process to the unique country context. The IRRP will reveal new generation source development options along with optimal energy infrastructure development options. Furthermore, IRRP will form a firm base for knowledge-based decision-making for energy sector development.

Develop policy and legal framework for heat supply in cities and towns. Heat supply and heat energy production in urban areas are relatively local in nature compared to electricity, Internationally central district heating systems are major part of the development policies and planning of the cities and towns. Since Mongolia's transition to a market economy, district heating in urban areas has been left without a specific policy and regulation, and this sector has become one of the sources of air pollution, which is technologically outdated, dependent only on coal. On the other hand, the low interest in using renewable energy for heat supply is directly related to the price of heat energy. Therefore, considering the development policy of the sector separately from electricity, determining the long-term goals and measures such as bringing prices and tariffs to their real costs, introducing new techniques and technologies, training personnel will be important to solve problems of air pollution and shortage of heat supply.

IMPLEMENTATION MILESTONE 2: ENERGY EXPORTER MONGOLIA (2031 – 2040)

Finalize adaptation of strategies, policies, and related laws for the export of electricity to countries in North-East Asia, and also conclude agreements and negotiations on power trade with China, creating an enabling environment to develop infrastructure projects focusing on Mongolia's abundant energy resources. To strengthen regional energy cooperation, participating countries should conduct regular talks and negotiations and establish a permanent organization to organize bilateral and multilateral agreements on investments, network connections, high voltage (HV) interconnections, and the institutional development necessary to expand energy trade.

Develop and implement special policies and programs to support projects intended for electricity export by the Government. The Government of Mongolia should establish a special zone for electricity export projects, protect project land, conduct in-depth research into energy resources, create an infrastructure development roadmap, conduct environmental impact assessments, assess taxes, and generate other types of support as needed.

Some concern lies in how the countries participating in regional energy trade will treat issues related to tax and contract disputes. A new umbrella regulatory framework developed

in cooperation with the energy trading countries would address the majority of these issues, as would establishing an electricity export policy that is separate from Mongolia's national energy policy.

IMPLEMENTATION MILESTONE 3: LAND OF CLEAN ENERGY (2041 – 2050)

Strengthen relevant policy, laws, and regulations for the low-carbon energy system only. This phase involves supporting and adapting modern technologies that help the sector to achieve its objectives in energy supply reliability, dependence, air pollution, and climate change. These include: (1) adoption of regulatory environment enabling incentives for ancillary service, followed by the establishment of attractive tariffs; (2) broad utilization of energy storage technologies; (3) hydrogen technologies; (4) small and medium hydro power plants (HPP); and (5) renewable energy heating technologies.

Mongolia is also evaluating nuclear energy as a possible zero-emission energy source; however, the country must develop and adopt all required standards, regulations, approvals for nuclear fuel and nuclear waste storage, transportation, and nuclear power plant operation safety guidelines. Any required legal documents shall follow the Guidance Document for Countries Introducing Nuclear Power published by International Atomic Energy Agency.

One alternative path for net zero-emission in Mongolia's energy sector is the introduction of green hydrogen. As the country evaluates large-scale utilization of green hydrogen for heat and power, Mongolia must develop and adopt all necessary legal regulations, documents, and standards. Mongolia's government must review the list of legal documents necessary to produce, store, transport, and use green hydrogen.

To successfully scale and adopt clean technologies in Mongolia, the country must also monitor and curtail the use of non-clean fuels and technologies like coal. This plan recommends that the government restrain non-clean energy sources, uses, and technologies, encouraging a shift to clean fuels in industry and expanding eligible fuels like hydrogen and its derivatives.

Beyond 2040, Mongolia needs to pursue a strategy of trading only clean energy through the electricity export network, giving countries like China, South Korea, and Japan the opportunity to reduce their own CO2 emissions by importing clean energy from Mongolia.

PILLAR II: DEFINE OPTIMUM ENERGY MARKET STRUCTURE

VISION-2050 ENERGY MARKET OBJECTIVES

This chapter presents recommendations for defining the optimum energy market structure, in line with implementation phases as laid out in Vision-2050.

Vision-2050 Activities

4.1.29. Improve the environment for training, reorganization, and cooperation for the purpose of establishing a link between foreign investment and national economic entities.

4.2.40. Implement the Asian integrated power network initiative in cooperation with the countries of Northeast Asia.

4.4.15. Expand trade cooperation with the USA within the strategic partnership agreement and expand it into the investment and technology spheres.

4.5.8. Acquire information on technological innovations required for small and medium producers through diplomatic missions in foreign countries and expand investment partnerships by organizing international exhibitions, fairs and business meetings.

Source: Vision-2050, the long-term national development policy for Mongolia.

BACKGROUND

The current models in the energy market, such as single-buyer model, spot and competitive markets, which serve the central electricity system, needs to be evaluated and improved.

Although the single-buyer model, which has been in use since 2002, has advantages such as stable and reliable cash flow of companies in the sector, and quick settlement, the main decisions of this market are still made in a vertical system. Therefore, in the future, it is necessary to have market rules regulating the market, to support the element of competition, to improve the contractual responsibilities of market participants, and to make payments based on invoices.

The Government has supported the competitive procurement of renewable energy in recent years. Following the implementation of laws and policy measures taken by the Government in 2007 to address growing energy consumption needs through renewable energy sources, 271.2 MW of solar, wind, and hydropower plants have been put into operation in Mongolia, making up 17.5 percent of the total installed power capacity of the country at end of 2021.

To further benefit from lower costs of renewable energy technologies worldwide, the Renewable Energy Law in 2019 includes a mechanism for competitive selection of renewable energy projects. By selecting projects through this competitive tender (auction) mechanism, the Government hopes to see a reduction in the total cost of RE projects, as well as an overall decrease in the price of electricity sold to consumers.

The present tariff structure in Mongolia does not reflect the full cost of service and is heavily subsidized. This lack of cost recovery has led to financial challenges that prevent much-needed investments in refurbishing infrastructure-which some estimate will require $4 to $5 billion by 2030[2] -in an environment that is not conducive to private investment. Additionally, in response to the COVID-19 pandemic, the Government of Mongolia paid the utility bills (electricity, heat, water, and waste) of households and some enterprises for approximately seven months, ending July 1, 2021. The impact of these decisions on the financial resilience of the national energy system has yet to be fully assessed.

2 The Government of Mongolia (2022)

IMPLEMENTATION MILESTONE 1: ENERGY SELF-SUFFICIENT MONGOLIA (2022-2030)

The current single-buyer model needs to be improved through the introduction of transparent revenue allocation and greater responsibility of parties involved in the market. The National Dispatching Center (NDC) in Mongolia serves as the single buyer. The price of electricity to be sold and the purchase price for distribution and supply is determined by ERC according to approved methodology. The method of allocating a company's income; however, needs to be more open and transparent based on the actual performance of the companies' operation.

Although the NDC acts a commercial operator "single-buyer," it does not have any financial obligations to producers and suppliers and is not required to accept responsibility for the accumulation of debt due to insufficient revenue collection in the single-buyer market, for example, leading to a large amount of inter-sector debt has no owner and is not tracked by proper documentation like invoices.

In the near future, Mongolia must improve the oversight and responsibility of parties involved in the single-buyer model, ensuring that the NDC as market operator assumes financial and technical responsibility ahead of energy producers and transmission and distribution companies. In general, the energy market of Mongolia would benefit from optimizing costs, covering investment and operational costs, and better resource allocation. Also, it is necessary to improve the monitoring and evaluation of the financial reports for price and tariff setting, and to prepare the accounting of energy companies in accordance with international accounting standards (IAS) and to include it in a unified program.

Energy sector reforms must consider impact on economy, social life, and the environment, and ensure a balance. As a backbone of the economy, the energy sector is responsible for creating opportunities for economic development and providing reliable energy to consumers by expanding generation capacity to meet growing consumption. The energy sector is responsible for providing energy to all segments of the population at an affordable price and contributing to environmental responsibility and sustainability.

Although competition increases the participation of the private sector, the enabling conditions for competition are limited by the lack of sufficient energy capacity to meet demand. For the distribution segment with high electricity losses, Mongolia must focus on improving its technical and financial performance by improving governance and management. For new energy capacity add, a competitive bidding system should be used. It is especially important to develop technical capabilities for least-cost planning to determine which generators to build.

Low energy prices do not attract the large-scale investment needed for clean and advanced traditional energy technologies. Mongolia's energy tariffs are lower than the its costs, preventing the country from carrying out necessary maintenance and services to existing CHPs and transmission and distribution networks. In the future, Mongolia must introduce a full cost-recovery tariff and carbon tax in order to introduce new technologies into the energy sector. Incorporating carbon pricing and taxation into energy tariffs, however, will take considerable time and create social and political debate, possibly slowing or dissuading further investment.

The rules and regulations governing the energy market need to be updated, such as the grid code. Provide additional improvements and updates to the grid code, as well as open access rules and regulations, on how clean and renewable energy technologies should be regulated. Particularly, regulations on how to coordinate and operate solar and wind power plants, management control, information system technology in the transmission and distribution networks, and distributed generators, storage, smart meters, and electric vehicle chargers in the consumer area should be included.

Governance of state-owned energy companies urgently needs improvement. Price and tariff issues are not only a problem for clean energy technologies, but also for coal-fired power plants. State-owned enterprises (SOEs) dominate the country's infrastructure sector, hold the highest number of jobs and contribute immensely to economic growth. In recent years however, the performance and quality of SOEs has deteriorated due to corruption, mismanagement, and lack of well-trained personnel.

Appointing an independent management team responsible for day-to-day operations would improve the performance of the SOEs. The separation of ownership and management activity of the SOEs would ensure that the management team has no influence from political parties or Government officials.

Further, to improve the responsibility of participating companies in the current single-buyer model, ERC should: (1) allocate revenue based on the actual production and performance of the power purchase agreement of companies; (2) make energy sale and purchase agreements with the NDC more detailed; (3) strictly enforce the provisions of agreements; and (4) operate under the principle of independent legal entities.

Finally, if the ERC approves new tariffs for the next three to five years, it will ensure that SOEs have guaranteed income that can attract further investments.

Strengthening the capabilities of Energy Regulatory Commission (ERC) to operate independently will stabilize the sector. In order to regulate the energy sector according to market principles, it is necessary to reduce the political influence affecting the decision-making of the ERC and further ensure its independence.

For example, the five commissioners of the ERC can be appointed by the Parliament of Mongolia, rescinding their association with any political party during his/her work at the Commission. A fully independent commission will be able to establish clear tariff-setting methodology for capital cost recovery and indexation, as well as a structure to manage the Government's assistance for consumers' energy bills transparently and effectively.

IMPLEMENTATION MILESTONE 2: ENERGY EXPORTER MONGOLIA (2031 – 2040)

Mongolia can play an important role in the creation of the Northeast Asian power market as an electricity exporting country. To participate in the Northeast Asian energy market as an energy supplier, Mongolia first must create an enabling investment environment to attract investment for building energy power plants and transmission infrastructures with policies, regulations and market rules separate from its national energy market. The regional energy market would benefit from a separate market model modeled after other well-designed global energy markets, and drawing from the experience and advice of other specialized international organizations and similar stakeholders.

Mongolian least-cost electricity markets are confronted by the necessity to decarbonize electricity production. Mongolia actively supports international accords to reduce greenhouse gas emissions and promote renewable energy. Most recently Mongolia joined the Paris Agreement, pledging to reduce greenhouse gas emissions by 22.7 percent by 2030.

One of the key drivers of this commitment is renewable energy. So far, the country has awarded high-tariff, long-term Power Purchase Agreements (PPAs) with 271.2 MW of solar and wind power plants. At current levels, these solar and wind tariffs are relatively high compared to average consumer tariffs. The NDC is facing challenges to meet Least Cost Principles and the development of the wholesale market due to the mandatory sales conditions of the PPAs in the single-buyer model. By introducing competitive auctions; however, Mongolia can select competitive new energy vendors and reduce costs.

Renewable energy power plants need to participate in the energy market to the extent that they are competitive and bear some degree of price uncertainty risk, just like conventional plants. Renewable energy power plants are protected from price uncertainty and risks by operating with long-term, fixed US dollar tariffs in the country. In the future, in order to compete with traditional energy technologies in terms of price, renewable energy project investors need to bear the price risk to a certain extent and support the operation of the power system with a comprehensive planning process.

A relatively small energy market and huge resource of renewables must be considered when designing the optimum structure of the local and international market. The existing structure to organize competitive procurement needs to be assessed. The lack of institutional and regulatory resources, institutional settings with high tendency of corruption, weakness of judicial independence, and strong political influence may hinder efforts to achieve competitive market structure. Independent regulation of the electricity market would be supported by enshrining in the law the subject of approving the model and rules of the electricity market.

Government leadership will be instrumental in improving the market structure of the energy sector. A comprehensive policy package to develop the domestic energy market structure and improve enabling conditions to achieve sustainable energy transition should be developed and adopted. Increasing the number of qualified human resources, decision-makers, lawyers, and investors to promote commercialization of SOEs are essential components of the policy goals.

Private sector involvement has high potential to increase performance of the energy network but needs full policy and investment support to be realized. Mongolia must continue to introduce modern technologies and ensure mainstreaming of viable and successful pilot projects. In order to improve the investment environment for renewable energy and energy saving projects, the following actions may be explored: (i) establish a green energy investment fund, (ii) prioritize green projects in loan products of financial institutions, (iii) provide guarantees and insurance for loans, and create conditions for long-term low-interest loans. Reskilling and upskilling programs for jobs at risk from increased digitalization in the energy sector will remain an important step to becoming a reliable supplier of clean energy. Implementing dynamic grid fees and enabling peer-to-peer and community trading to foster local energy markets must be achieved.

IMPLEMENTATION MILESTONE 3: LAND OF CLEAN ENERGY (2041 – 2050)

Transitioning to a net-zero emission energy system requires integrating carbon and supporting policies into a sustainable electricity market system. While competitive markets will be a key part of this transition, the laws, regulations, and support systems that enable clean energy technologies to compete at the lowest cost in the energy market will need to be in place.

By 2050, the principles of market design might be changed as clean energy technologies and digital transformation dominate the energy market. In the domestic energy market by 2050, clean energy sources such as solar, wind, hydropower, and natural gas, as well as green hydrogen and nuclear plants, may exceed the capacity of coal plants. In addition to the use of energy-efficient technologies (such as Demand Side Management, Battery Energy Storage Systems), there is also a tendency to use widely distributed renewable energy generators for consumers. With so much present digitalization into the energy market, it is difficult to define what exactly the market will look like by 2050.

A fully restructured retail electricity market can be introduced but enabling conditions must be fulfilled. To make regulated retail electricity prices competitive, certain enabling conditions must be met, such as opening the market up to third-party access, creating the wholesale market where generators and large consumers can be directly contracted to trade electricity, and making a sufficient number of power stations available to participate in the market and fully utilize meet energy demand.

PILLAR III: ADOPT DEMAND-SIDE MANAGEMENT PRACTICES

VISION-2050 ENERGY DEMAND OBJECTIVES

This chapter presents the current state and recommendations on energy demand objectives as laid out in the implementation phases of Vision-2050.

Vision-2050 Activities

3.2.2. Make construction blueprints of housing to fit the purchasing power of citizens, and improve norms, standards, relevant laws and legal environment.

3.2.12. Create a sustained system of policy and financial support for introducing green housing.

3.2.13. Use state and local budgets as well as other investment sources to provide as a priority the engineering infrastructure to common and fringe zones of ger districts, create space for the construction of new housing through direct exchange of sites with built infrastructure for state-owned or private housing in line with the will and initiatives of citizens.

4.2.41. Introduce innovation, advanced and smart technology in the energy sector and pursue the policy of financial independence, efficiency and saving.

6.4.3. Promote environmentally friendly and economical green ideas, attitudes and practices such as sustainable green cities, green buildings, green lifestyles, and resource conservation.

6.4.10. Support and develop domestic manufacturers of green and energy efficient products in the construction sector.

9.3.4. Increase the supply of various types of housing (income-based, rental, green) and implement a housing program for 150,000 households.

9.3.12. Introduce multiple and smart public transportation (such as BRT, electro-magnetic transportation).

9.3.24. Establish a network to charge vehicles with electricity and gas.

9.3.36. Implement a national energy saving program.

9.3.37. Build partial and independent heating sources with environmentally friendly and advanced technology that work during peak hours in remote areas of the capital city, connect them to the central heating supply system and increase their efficiency.

Source: Vision-2050, the long-term national development policy for Mongolia.

BACKGROUND

Mongolia's Nationally Determined Contributions (2019) in the Paris Agreement agree to reduce greenhouse gas emissions by 27.2%, where the energy sector alone accounts for 50% of the total emissions by 2030. It is critical to implement green projects and activities in the economic sectors for low greenhouse gas emission production, the introduction of eco-friendly technology, improvement of energy efficiency and productivity, and scaling up use of renewable and other new sources of energy.

Energy efficiency can reduce power and fuel import dependence, minimize risk of increasing energy prices, and defer requirements for capacity additions. For Mongolia, the Government has initiated policies and programs to meet the growing demand for energy continuously and reliably and to reduce dependence on imported energy. To implement energy saving and efficiency on a large scale, Vision-2050 aims to introduce innovation, advanced and smart technology in the energy sector, and policies that drive financial independence and efficiency.

IMPLEMENTATION MILESTONE 1: ENERGY SELF-SUFFICIENT MONGOLIA (2022-2030)

Legal frameworks to improve energy efficiency should be developed and adopted, specifically for buildings, industries, and transportation. Vision-2050 plans to implement a national energy saving program built on lessons learned and recommendations to address challenges and gaps in introducing more efficient technologies. The introduction of an energy efficiency rating system/Minimum Energy Performance System (MEPS) to construction, industrial and

transportation sectors while strengthening the enabling environment, could be strategically important entry points to developing supportive legal framework.

An existing bottleneck to developing an energy efficiency market and energy service companies is the current tariff rate that does not reflect actual costs of energy. The introduction of an index-based or a cost-reflective energy tariff would help develop the energy efficiency market and attract more investments and efficient technologies. It may also trigger consumers to purchase more expensive, energy-efficient electric appliances, while incentive mechanisms may encourage consumers and businesses to purchase and import more efficient appliances.

The existing building energy rating system (adopted in 2021) should be strengthened and applied to the insulation of old buildings and to the design and commissioning of new buildings. Specifically it is important to apply energy efficient standards to new building programs. For instance, Vision-2050 stipulates the construction of green housing for at 150,000 households that would create demand for 600MW additional capacity of power at a minimum, unless connected to other low emission power sources.

The Mongolian Government must commit to introducing efficiency standards and labelling requirements for energy intensive appliances – including air conditioning systems, distribution network transformers, motors and inverters, electric heaters, refrigeration and freezing, and washing machines. Relevant laws and legal environment, such as the Energy Conservation Law and the relevant regulations need to be updated accordingly.

IRENA's transformation pathways estimates that 350 million electric vehicles (EVs) will be needed globally by 2030. As of 2021, 4% of the global market share were EVs. In Mongolia, there were 428 EVs out of 1.2 million vehicles registered as of March 2022, resulting in the Government allowing EVs to charge from the grid. In line with the objectives of Vision-2050 to construct electricity and gas charging infrastructure for vehicles, the country needs to generate a development and investment roadmap to promote the healthy and rapid development of the EV industry and evaluate its impact on the energy demand.

Key aspects of the roadmap shall include key focus areas such as: (1) construction of charging infrastructure; (2) strengthening the capacity of the power grid to meet increased demand from EV charging facilities; (3) adoption and improvement of standardized specifications and technological innovation; and (4) development of relevant pilot projects (5) financing and business model

More structured efforts to increase awareness about energy efficiency's potential that yield major benefits should be increased to gain more political buy-in and support from the public. It shall be communicated across sectors that energy efficiency is an immediate way to respond to greenhouse gas (GHG) emissions reductions with the least cost and efforts. Mongolia should also create and maintain National Energy Balance accounting.

Utility DSM program is introduced at designing, planning, and implementing stages. The aim of such intervention is to change levels and patterns of power consumption and monitor the impact of these. The DSM programs administered by the utilities should be focused in two mainstreams: (1) to decrease total electricity demand through energy efficiency measures, and (2) to implement load management programs through changing load-shape (load shifting programs).

To achieve efficiency, the DSM programs can encourage and obligate users to purchase and use more efficient technologies, rebating or subsidizing the purchase or installation of such technologies and increasing public awareness about multiple benefits of energy conservation. Often, users are not well aware of the possibility of using more efficient technologies; ensuring users have information about the benefits of such appliances is critical.

For instance, communications such as text messages and energy labels can help end users better understand available technologies and to make purchasing decisions. Depending on the utility's financial capacities, rebates to purchase more efficient technologies or a monthly discount on electric bills can be provided as incentive measures.

At the same time, utilities should be focused on identifying effective load management programs. One of the recommended approaches can be targeted to modifying patterns of energy consumption of large energy users/energy intensive industries, such as mining companies.

IMPLEMENTATION MILESTONE 2: ENERGY EXPORTER MONGOLIA (2031 – 2040)

Legal framework of DSM/Demand response is reviewed and strengthened. Constructing new apartments, better insulation of existing buildings, and investing in highly energy efficient appliances is recommended. Government programs to temporarily bear or resolve additional costs associated with energy efficiency measures must be implemented to attract interests from the market and construction companies, through programs like the LED Program, Green or Energy efficient construction materials, Efficient Motors and Inverters, Better Windows, Sustainable EVs program etc.

MEPS standards shall be integrated into public procurement and the maintenance of energy conservation should be further strengthened and integrated with Artificial Intelligence and Big data concepts. Supporting local research and innovation is a significant way to integrate these concepts.

Electrification is also a viable option for resolving underlying issues throughout the transportation sector, such as environmental concerns and emissions of particulates, nitrogen oxide, and carbon dioxide. Sustainable business models for EVs and low-emission means shall be explored and tested, and the complete environmental impact of EVs compared with traditional combustion engines will be evaluated against existing laws and regulation on emissions of toxicity and impact on reduction on air and environmental pollution.

Utility scale DSM program is achieved. In this phase, utility administered DSM programs are introduced and gradually scaled up to reduce overall energy consumption and to achieve sustainable reduction in the peak load. The Government should consider setting up sustainable incentive mechanisms to promote utility scale DSM programs across energy systems. Implementing these kinds of programs has multiple benefits to accelerate low carbon energy transition, reduce air pollutants, Short-lived Climate Pollutants (SLCPs), and costs for both utilities and end users.

IMPLEMENTATION MILESTONE 3: LAND OF CLEAN ENERGY (2041-2050)

Legal and regulatory framework is adopted. The Government should introduce a system to encourage and incentivize energy saving and efficiency activities and introduce energy efficiency requirements and standards in projects implemented with state and local budget investments. A financing system for investing in energy efficiency projects should be fully operational.

Long-term decarbonization strategies for the electrification of transportation sector would enable widespread adoption of EVs. Smart solutions such as smart charging facilities for EVs could introduce more variable REs in the grid and encourage behavioral adaptation to reduce energy demand. Policy package and investment plans need to consider and include assessment and mitigation of the environmental impact and entire lifecycle assessments, including disposal of used batteries of EVs.

Full scale utility scale DSM program is adopted. The DSM programs are one of the most cost-effective solutions to strengthen energy security. The Mongolian energy sector currently faces delays to commissioning additional sources and plans to assess implemented DSM programs should be made. A comprehensive monitoring system of the DSM programs to measure their impact and achieved energy savings would be beneficial. These evaluations would give utilities and regulators a better understanding about what kinds of DSM programs are most sustainable over time. The collection of consistent and accurate data about the costs and impacts of the programs is important for future power system planning, and the potential of energy efficiency should be forecasted in future electricity demand projections.

PILLAR IV: OPTIMIZE ENERGY MIX

VISION-2050 ENERGY GENERATION MIX OBJECTIVES

This chapter presents the current state and recommendations for the implementation phase of Vision-2050 to optimize Mongolia's energy mix.

Vision-2050 Activities

4.2.7. Develop energy and engineering infrastructure to support economic development

4.2.8. Expand power plants, construct electricity transmission lines, sub-stations and new energy sources and become self-sufficient in electricity production

4.2.34. Expand the capacity of thermal power stations engaged in ensuring energy reliability, safety and sustainability, build new power stations, ensure full supply of domestic energy needs and carry out export of electric power

4.2.35. Construct aerial electricity transmission lines of Mongolia's integrated energy system's vertical and horizontal axles and establish a smart unified system based on advanced infrastructure.

4.2.36. Build up a regime regulation facility of the integrated energy system and reduce dependency on imported energy.

4.2.37. Bring the existing renewable energy capacity to 30 percent and use 10 percent of outgoing river flows for power production and other purposes.

4.2.38. Utilize modern sources of renewable energy in the local heating supply.

4.2.39. Carry out enlargement and renovation of heating sources and heating network to improve the quality and availability of heat supply in cities, soums, and settlements.

4.2.42. Use solar, wind, water, biomass, liquid and gas fuel, geothermal, fuel cell element and other new energy sources in adjustment with source strength balance.

6.4.17. Implement green projects and programs to develop renewable energy, reduce greenhouse gas emissions, reduce waste and increase efficiency of resource utilization through the United Nations Green Climate Fund and other international financial instruments.

8.1. Develop the independent integrated energy system, shift to a smart system for the mixed use of renewable energy sources, and become an energy exporter.

Source: Vision-2050, the long-term national development policy for Mongolia.

BACKGROUND

The Government of Mongolia is working towards increasing the reliability and independence of the energy system. In 2020, the Government of Mongolia developed the "New Recovery Policy" with six goals to focus on in coming years, one of which is the Energy Revival Policy (ERP). The main goal of ERP is focused to eliminate insecurity and low energy supply – a major bottleneck for the growth and expansion of Mongolia's economy. A total of 22 projects (new coal power plants, expansion of existing CHPs, hydro, and transmission grid) and programs will be implemented within the ERP. It is estimated that approximately US$ 4.8B (MNT 14.9 trillion) will be required. Mechanisms of public-private partnership (PPP), public funding, and private investment will be used for implementing the identified projects.

Rapid urbanization required to add capacity for electricity and heat generation. Mongolia's energy system has reached a level where it cannot meet the growing demand for electricity and heat energy. Presently around 20% of the country's electricity is imported from Russia and China.

According to international standards, the power system should have additional reserves equal to at least 20% of the total installed capacity. Mongolia has no power reserves and is at a high level of risk. The Government of Mongolia has started implementing six major energy generation expansion projects in order to increase the reliability and independency of the energy system.

The total installed capacity of these projects will be 810 MW of electricity and 285 Gcal/h of heat. It is estimated that approximately US$1.36B (MNT 4,233B) will be required for investment.

Table 1: List of planned expansion projects

Project title	Installed capacity, MW (Gcal)
CHP-3 expansion	325
CHP-2 rehabilitation	100
Choibalsan CHP expansion	50
Amgalan HP expansion	116 (100)
CHP-4, Steam boiler expansion	500t/h
Gas power plant	219 (185)

New electricity and heat generation projects are planned to meet growing needs of industrial development, specifically from the mining sector. A total of five mega projects of coal and hydropower plants have been planned in all major regions of Mongolia to support the economic development of mining projects, increase electricity supply reliability in the western province, and reduce electricity capacity import. The total installed capacity of these projects will be 1550 MW of electricity it is estimated that approximately US$ 2.92B (MNT 9,128B) will be required for investment.

Table 2: List of planned mega projects

Projects	Installed capacity, MW
Tavantolgoi power plant	450
Erdeneburen hydro power plant	90
Egiin hydro power plant	315
Bagakhangai power plant	300
Baganuur CHP	400

Power transmission lines and substations are important for ensuring the reliability of electricity in the regions and connecting clean and renewable energy projects to the energy system. As part of the objective to establish a unified energy system that connects all its regions, a total of seven projects are planned within the framework of the New Revival Policy (NRP) of Mongolia.

The total length of these projects will be 1962 km of 220kV overhead power transmission lines and it is estimated that approximately US$ 411.8M (MNT 1280.7B) will be required for investment.

Table 3: List of planned transmission line projects

Projects	Line length, km
Erdeneburen-Myangad-Uliastai	468
Tavantolgoi PP-Oyutolgoi	167
Sainshand-Tsagaansuvraga	204
Baganuur-Chinggis-Choilbalsan	518
Baganuur-Choir	188
Mandalgovi-Arvaikheer	287
Baganuur-Nalaikh-UB	130

The country is diversifying the energy generation mix with green and modern energy technologies in alignment with the Paris Agreement. The NRP diversifies the structure of the energy generation mix, is more environmentally friendly, and emphasizes low greenhouse gas emission technologies for energy supply. For example, renewable energy, natural gas, green hydrogen, and nuclear energy technologies are included.

Mongolia plans to build wind and solar power plants and conduct studies on the potential use of green hydrogen based on renewable energy and domestic natural gas, coalbed methane (CBM), and nuclear energy in the longer term.

Besides technical studies, the development of environments for investment, tax, regulation, institutional capacity building, and human resource are also considered in Vision-2050.

Table 4: List of planned clean and renewable projects

Project title	Installed capacity, MW
Wind Park	15
Solar PP	35
Green hydrogen	Pre-feasibility study
Natural Gas	Pre-feasibility study
Nuclear energy	Pre-feasibility study

IMPLEMENTATION MILESTONE 1: ENERGY SELF-SUFFICIENT MONGOLIA (2022-2030)

In order to increase the reliability and security of the energy supply, the country must introduce load following capacity into the energy system. Rapid urbanization and increased economic activity cause a sharp increase of both heating and power demand, currently met by existing thermal power plants. This situation leads to increased fluctuation in the demand profile, requiring additional load following capabilities to meet energy demand cost-effectively. An increased share of intermittent renewable energy sources, however, causes problems due to the inflexibility of the existing power system. These can be addressed by adding load following capacity such as utility-scale battery storage, hydro (pumped) power plants, and gas fueled power plants.

The integrated planning of digital technologies in the sector needs to focus on new renewable energy production in the generation mix, while maintaining the security of supply of the entire system. This includes smart grids and artificial intelligence for the electricity transmission grids and in the management systems to be able to monitor and respond adequately to a greater production from RE.

Regional electricity connectivity will improve the reliable and stable operation of the power system. Mongolia needs to create an integrated energy system by connecting the western, Altai-Uliastai , eastern, and central region systems to create opportunities for efficient use of power plants in the regional systems and further connect with the Inner Mongolian energy system through the OT transmission line.

IMPLEMENTATION MILESTONE 2: ENERGY EXPORTER MONGOLIA (2031-2040)

Distributed energy generation to maximize the use of local renewable energy resources need to be prioritized. Intelligent infrastructure built on digital energy management systems would help to scale up technologies. Energy demand-side management goes hand-in-hand with distributed energy generation to achieve long term sustainability and unlock financial resources. Furthermore, the energy sector needs research and development spending focused on clean energy technology adoption.

Adoption of new CHPs with alternative fuels – hydrogen, coal gasification, nuclear, gas, CBM – are identified. Hydrogen should be produced from various renewable energy sources. Green hydrogen production facilities should be constructed and commissioned. In addition, carbon capture facilities at the existing non-clean fuel-powered heat and power generating sources need to be introduced.

The regional power trade in the Northeast Asian region must be established. To become an energy exporter in the region, Mongolia is planning construction of cross-border energy trade infrastructure to support 10 GW of renewable (wind, solar, and hydro) energy installed capacity by the end of year of 2036.

IMPLEMENTATION MILESTONE 3: LAND OF CLEAN ENERGY (2041-2050)

Wind and solar renewable energy sources are developing and the system still faces challenges to maintain stable operation of the power system. To overcome the high volatility of renewable energy sources, the Government needs to develop more flexible energy system infrastructure. Flexibility could be achieved by adopting increasing decentralization and digitalization. The Mongolia energy system needs a more flexible energy and electricity market to facilitate energy transition.

Cross border power trade through the regional power market needs to be established. The vast energy generation possible based on renewable energy resources needs to be balanced with large scale adoption of energy storage technologies. Capacity additions of cross border energy trade will require building infrastructure with alternative fuels, such as green hydrogen. The cross-border energy trade infrastructure to support 100 GW of renewable (wind, solar, and hydro) energy remain to be built.

INSTITUTIONAL ARRANGEMENT

4

Sumber solar power plant, 10 MW, Gobisumber aimag, Mongolia.

4 INSTITUTIONAL ARRANGEMENT

Strong institutional arrangements ensure supportive decision-making and efficient implementation of Vision-2050 achievements in the energy sector. This roadmap is intended to inform national decision-makers on the incremental steps needed to accelerate energy transition and improve the energy security of the country. Decision-makers need to have evidence-based progress to evaluate and identify the right course of action for future investment plans.

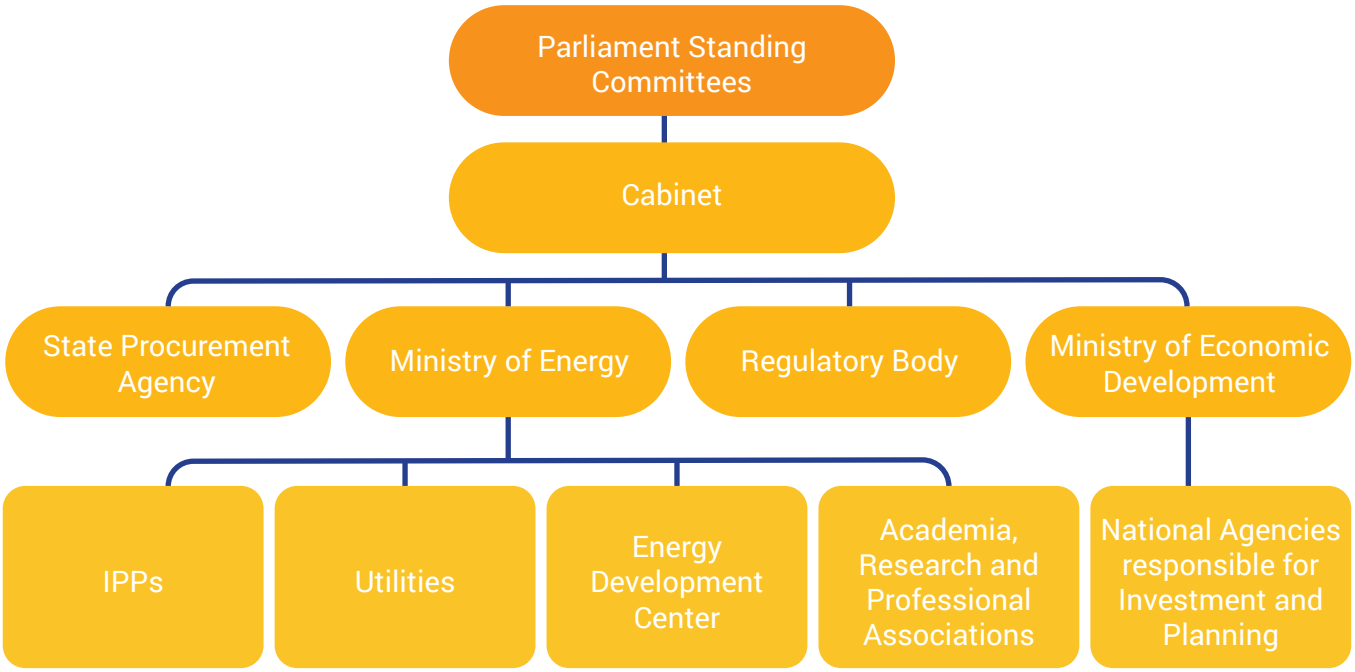
To set up a sustainable institutional arrangement, this roadmap suggests defining transparent objectives and outputs, establishing legal frameworks, securing human and financial resources, and developing comprehensive systems and tools for monitoring and reporting. This will require high-level political buy-in and support through funding and legal frameworks. For energy transition, flexible and well-functioning institutional arrangements are critical to facilitate a consistent enabling environment.

Four fundamental principles need to be adopted to facilitate this environment:

- Support the coordination of relevant agencies in introducing modern technologies and implementing mega-scale infrastructure projects in the energy sector
- Strengthen the regulatory framework
- Build technical capacity of the public sector, SOEs and NGOs in the energy sector
- Develop financing mechanisms and promote PPPs to increase engagement of the private sector and its investment
- Minimize the establishment of new institutional body and new bureaucracy

Mandates for government ministries, agencies, academic and research institutions, and private sector actors must be clearly established and updated to increase the share of renewables and achieve energy efficiency across the sector.

Exhibit 3: Model structure of institutional arrangements for Vision-2050 energy targets



Parliament's Standing Committees continue to be responsible for energy governance though a wide range of functions to develop clean energy and energy efficiency with support of the State Procurement Agency. The MOE and the ERC should be the primary actors implementing the goals stated in the Vision-2050. These two government institutions share responsibility for energy efficiency policy and regulation.

Measures to be taken for regulatory legislation:

- Main laws of the energy sector need to be reviewed and amended to reflect long-term policy goals of Mongolia
  - Law on Energy
  - Law on Renewable Energy
  - Law on Energy Conservation
- Policy instruments, technical regulations and guidelines, and norms and standards to support implementation of Vision-2050 to be selected and adopted to increase use of renewables and promote energy efficiency across the country
- Existing and new institutional arrangements strengthened to perform legal mandate of key institutions.

The energy transition is a global effort requiring international cooperation. Both learning and attracting investment from other countries and regions can benefit Mongolia. The state procurement policy package should be transparent and supportive to attract more financial resources to successfully implement the recommendations laid out in Vision-2050. Strengthening collaboration with development partners and developed countries at a strategic level will play a critical role.

5 TIMELINE

Sainshand wind park, 55 MW,
Dornogobi aimag, Mongolia.

TIMELINE 5

PILLAR 1 IMPROVE LEGAL FRAMEWORK

IMPLEMENTATION MILESTONE 1
ENERGY SELF-SUFFICIENT MONGOLIA
(2022 – 2030)

- Review relevant policy, laws and regulations, including investment, bankruptcy, customs, tax, development, digitalization, etc., and revise where needed.
- Digital solutions in core infrastructure development such as smart meters are integrated into national energy strategies and development plans are prioritized.
- Develop and adopt Mongolia's Integrated Resource Resilience plan (IRRP)

2022

2030

IMPLEMENTATION MILESTONE 2
ENERGY EXPORTER MONGOLIA
(2031 – 2040)

- Finalize adaptation of strategies, policies, and related laws for the export of electricity to countries in North-East Asia
- Develop and implement special policies and programs to support projects intended for electricity export by the Government.

2040

IMPLEMENTATION MILESTONE 3
LAND OF CLEAN ENERGY
(2041 – 2050)

- Strengthen relevant policy, laws, and regulations for the low-carbon energy system only.

2050

PILLAR 2 DEFINE OPTIMUM ENERGY MARKET STRUCTURE

IMPLEMENTATION MILESTONE 1
ENERGY SELF-SUFFICIENT MONGOLIA
(2022 – 2030)

- Energy sector reforms must consider impact on economy, social life, and the environment, and ensure a balance.
- Although competition increases the participation of the private sector, the enabling conditions for competition are limited by the lack of sufficient energy capacity to meet demand.
- The rules and regulations governing the energy market need to be updated, such as the grid code.
- Governance of state-owned energy companies urgently needs improvement.
- Strengthening the capabilities of Energy Regulatory Commission (ERC) to operate independently will stabilize the sector.

2022

2030

IMPLEMENTATION MILESTONE 2
ENERGY EXPORTER MONGOLIA
(2031 – 2040)

- Mongolia can play an important role in the creation of the Northeast Asian power market as an electricity exporting country.
- Mongolian least-cost electricity markets are confronted by the necessity to decarbonize electricity production.
- Renewable energy power plants need to participate in the energy market to the extent that they are competitive and bear some degree of price uncertainty risk, just like conventional plants.
- A relatively small energy market and huge resource of renewables must be considered when designing the optimum structure of the local and international market.
- Government leadership will be instrumental in improving the market structure of the energy sector.
- Private sector involvement has high potential to increase performance of the energy network but needs full policy and investment support to be realized.

2040

IMPLEMENTATION MILESTONE 3
LAND OF CLEAN ENERGY
(2041 – 2050)

- Transitioning to a net-zero emission energy system requires integrating carbon and supporting policies into a sustainable electricity market system.
- By 2050, the principles of market design might be changed as clean energy technologies and digital transformation dominate the energy market.
- A fully restructured retail electricity market can be introduced but enabling conditions must be fulfilled.

2050

PILLAR 3 ADOPT DEMAND-SIDE MANAGEMENT PRACTICES

IMPLEMENTATION MILESTONE 1
ENERGY SELF-SUFFICIENT MONGOLIA
(2022 – 2030)

- Legal frameworks to improve energy efficiency should be developed and adopted, specifically for buildings, industries, and transportation.
- Utility DSM program is introduced at designing, planning, and implementing stages.

2022

2030

IMPLEMENTATION MILESTONE 2
ENERGY EXPORTER MONGOLIA
(2031 – 2040)

- Legal framework of DSM/Demand response is reviewed and strengthened.
- Utility scale DSM program is achieved.

2040

IMPLEMENTATION MILESTONE 3
LAND OF CLEAN ENERGY
(2041 – 2050)

- Legal and regulatory framework is adopted.
- Full scale utility scale DSM program is adopted.

2050

PILLAR 4 OPTIMIZE ENERGY MIX

IMPLEMENTATION MILESTONE 1
ENERGY SELF-SUFFICIENT MONGOLIA
(2022 – 2030)

- In order to increase the reliability and security of the energy supply, the country must introduce load following capacity into the energy system.
- The integrated planning of digital technologies in the sector needs to focus on new renewable energy production in the generation mix, while maintaining the security of supply of the entire system.
- Regional electricity connectivity will improve the reliable and stable operation of the power system.

2022

2030

IMPLEMENTATION MILESTONE 2
ENERGY EXPORTER MONGOLIA
(2031 – 2040)

- Distributed energy generation to maximize the use of local renewable energy resources need to be prioritized.
- Adoption of new CHPs with alternative fuels – hydrogen, coal gasification, nuclear, gas, CBM – are identified.
- The regional power trade in the Northeast Asian region must be established.

2040

IMPLEMENTATION MILESTONE 3
LAND OF CLEAN ENERGY
(2041 – 2050)

- Wind and solar renewable energy sources are developing and the system still faces challenges to maintain stable operation of the power system.
- Cross border power trade through the regional power market needs to be established.

2050

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IMPORTANT NOTICES

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