



# Completion Report

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Project Number: 50318-001  
Technical Assistance Number: 9301  
July 2020

## Kazakhstan: Fostering the Development of Renewable Energy

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## TECHNICAL ASSISTANCE COMPLETION REPORT

<b>TA Number, Country, and Name:</b> TA 9301-KAZ: Fostering the Development of Renewable Energy		<b>Amount Approved:</b> \$1,000,000.00	
		<b>Revised Amount:</b> Not applicable	
<b>Executing Agency:</b> Kazakhstan Electricity Grid Operating Company (KEGOC)	<b>Source of Funding:</b> Clean Energy Fund <sup>1</sup> under the Clean Energy Financing Partnership Facility	<b>Amount Undisbursed:</b> \$29,488.00	<b>Amount Used:</b> \$970,512.00
<b>TA Approval Date:</b> 6 March 2017	<b>TA Signing Date:</b> 15 March 2017	<b>TA Completion Date</b>	
		<b>Original Date:</b> 28 February 2018	<b>Latest Revised Date:</b> 30 June 2019
		<b>Financial Closing Date:</b> 3 December 2019	<b>Number of Extensions:</b> 3
<b>TA Type:</b> Knowledge and support TA	<b>Nature of Activity:</b> Capacity development	<b>TA Arrangement:</b> Not applicable	

### Description

Kazakhstan is rich with oil, gas, and coal and, consequently, the power generation, designed during the Soviet era, is primarily based on fossil fuels. On 30 May 2013, the President of Kazakhstan approved the Concept for Transition of the Republic of Kazakhstan to Green Economy, which set targets for power generation from renewable energy sources (wind and solar) of 3% by 2020 and 10% by 2030.<sup>2</sup> Separately, Kazakhstan's Intended Nationally Determined Contribution under the 2015 Paris Agreement set a target to unconditionally reduce greenhouse gas (GHG) emissions by 15% (25% conditional) by 2030 compared to the 1990 baseline.

Achieving those ambitious targets required thorough analysis and planning. However, the country's national power system operator, Kazakhstan Electricity Grid Operating Company (KEGOC), had limited experience with renewable energy generation.<sup>3</sup> KEGOC did not possess sufficient technical capacity and tools to analyze the impact of integrating intermittent energy sources, such as solar and wind, into the grid. As a result, the applications from public and private sector developers on the construction of new wind and solar power plants were deferred until their impact on the power system was analyzed and adequate grid reinforcement measures were undertaken.

In August 2016, the Ministry of Energy requested the Asian Development Bank (ADB) to provide technical assistance (TA) for KEGOC to strengthen its capacity in power system planning for the integration of renewable energy sources into the national grid. In addition, the TA was expected to analyze the impact of various amounts of renewable energy generation on the power grid for different time horizons, and identify projects to minimize the impact and additional cost originating from the requirement to balance intermittent power generation from renewable sources.

This TA addresses one of Energy Sector Goals which includes development of renewable energy and reduction of greenhouse gas emissions, core development areas in the country partnership strategy for Kazakhstan, 2012–2016.

### Expected Impact, Outcome, and Outputs

Impact: electricity supply from renewable energy sources in Kazakhstan increased to 3% (in kilowatt-hour) by 2020.  
 Outcome: transmission system operator's capacity for planning and modeling of the integration of variable power generation sources into the Kazakh power system established.  
 Outputs: (i) KEGOC's transmission system planning and operations staff trained on modern system planning tools, (ii) KEGOC's system planning tools improved, and (iii) a list of transmission grid reinforcement projects necessary to integrate electricity generated from renewable energy sources prepared.

### Implementation Arrangements

The executing agency for the TA was KEGOC under the monitoring of the Ministry of Energy. The Energy Division of ADB's Central and West Asia Department closely monitored TA implementation.

<sup>1</sup> Financing partners are the governments of Australia, Norway, Spain, Sweden, and the United Kingdom.

<sup>2</sup> Government of Kazakhstan. 2013. *Decree No. 577: Decree of the President of the Republic of Kazakhstan dated 30 May 2013—Concept of Transition of the Republic of Kazakhstan to "Green Economy."* Astana. [http://www.pavlodar.gov.kz/page.php?page\\_id=66&lang=3](http://www.pavlodar.gov.kz/page.php?page_id=66&lang=3).

<sup>3</sup> KEGOC is a state-owned electricity transmission and dispatch joint-stock company.

Prior to the TA's approval, the International Finance Corporation supported KEGOC in selecting the most appropriate power system planning software. PowerFactory, produced by the German company, DlgSILENT, was selected as one of the three most used power system planning softwares in the world, and the only one which has (i) complete user interface, all-analytic functions, and customized add-ons in Russian language; (ii) full Russian language support; and (iii) the former Soviet Union-type equipment database. TA funds totaling \$410,000 was allocated in a consulting contract as provisional sums for procuring the PowerFactory software and its associated licenses. The software was procured in accordance with ADB's Procurement Guidelines (2015, as amended from time to time) under the direct contracting method.

The consulting part of the same contract was thereafter internationally tendered using the quality- and cost-based selection (QCBS) method (quality–cost weighting of 90:10), following ADB's Guidelines on the Use of Consultants, and was mobilized on 27 March 2017. The contract was awarded to DlgSILENT GmbH, which had the required expertise in transmission planning, analysis, and costing engineering. The TA planned to use 21 person-months of international consultant inputs, but instead utilized 21.5 person-months international and 2.5 person-months national consultants inputs. The Team Leader was replaced twice (as explained under the Lessons Learned and Recommendations) and, during the last phase, the project was managed by the Managing Director of DlgSILENT. The TA was extended three times (as discussed below).

DlgSILENT installed 9 Base Packages of PowerFactory at the central dispatch center, 11 in regional dispatch centers, and 2 in the grid development department. Additional advanced functionalities were installed in various departments of KEGOC. As planned, 68 licenses were provided within the 24-month validity period. KEGOC provided all the required hardware and other backup and support systems.

DlgSILENT's deliverables included (i) inception report; (ii) reports on transforming the system model into the format of PowerFactory, and on installing additional services considering the special features of the Kazakh energy system; (iii) report on the study for transmission planning, in lieu of renewables integration into the energy system; (iv) first draft final report; (v) second draft final report, with the client's conceptual comments and suggestions incorporated; (vi) report on the trainings conducted; and (vii) final report. In total, 10 reports were submitted.

It is important to note the professionalism exhibited by the DlgSILENT team. After the third TA extension, KEGOC made last-minute changes to the assumptions of the model that required major recalculations. The consultants completed the task within the TA timeframe. However, they were not able to travel to Kazakhstan to present the results within the TA closing date due to the unavailability of KEGOC's management. DlgSILENT requested a few months of extension, which was not granted by ADB. Since the new conclusions were critical for KEGOC and complex requiring personal explanation by the consultants, on 25 September 2019, the Managing Director of DlgSILENT traveled to Nur-Sultan at his own expense, and presented the findings to KEGOC's technical committee. After minor revisions, the final report was submitted to KEGOC and ADB on 20 November 2019.

### **Conduct of Activities**

Following were the main activities, which were undertaken as planned under the TA:

- (i) Trained KEGOC's transmission system planning and operations staff on PowerFactory.

The consultant conducted formal and extensive on-the-job trainings on the PowerFactory software for 30 KEGOC staff in September–October 2017. The trainings focused on (a) PowerFactory basic training, (b) modeling of renewables integration, (c) transfer capability calculation and the model used for perspective planning, (d) short circuit calculation and protection coordination, (e) power quality planning with PowerFactory, (f) transients simulation and dynamic stability, and (g) frequency stability calculation. Additional PowerFactory trainings and internship sessions for the 35 staff from the regional branches and the National Dispatch Center of KEGOC were conducted in March–April 2018. The interns applied the knowledge and skills they gained at the training in preparing various simulations and grid stability analysis. The trained employees also trained other KEGOC staff, specifically planning and system operation staff; thus, strengthening the institutional capacity of KEGOC to integrate renewable energy generation.

- (ii) Converted Kazakh power grid into PowerFactory, and ran various simulations for renewable energy integration.

PowerFactory software was installed in May 2017. Kazakh power grid was built in PowerFactory and passed the acceptance test in August 2017. Next, the consultants prepared demand growth reports on a regional basis. Finally, the consultants undertook over 1,000 various studies and simulations for renewable energy integration for three time horizons: 2020, 2025, and 2030. The analyses consisted of numerous steady-state and dynamic simulations for relevant operation scenarios (winter and summer, high and low demand). Transmission planning studies included steady-state analysis of regimes, load flow, contingencies n-1, transfer capacity, short circuit, dynamic stability, transient and oscillatory stability, as well as impact of renewables on the load schedule, and technical requirements for

grid connection of renewables. This was the longest period of the TA implementation due to the large amount of data, technical complexity of calculations, and frequently changed assumptions. The technical acceptance of all analyses and studies took place in November 2019.

(iii) Prepared list of grid reinforcement projects necessary to integrate renewable energy generation sources.

The above-mentioned studies resulted in the transmission expansion plan for the 10-year horizon (2020–2030) to support demand growth and generation expansion. The consultants identified network reinforcement measures to guarantee a secure operation of the system until 2030, and estimated investment costs for the proposed transmission expansion plan. Moreover, the consultants recommended alternative operational practices of the system operator that would minimize secondary generation reserve requirement and, consequently, reduce the cost of system operations.

The TA was to be implemented from March 2017 to February 2018 but was extended thrice to 30 June 2019. The reasons for the extensions were:

Extension 1 from 28 February to 30 June 2018: Building the Kazakh power grid model in PowerFactory required huge amount of data, which were far more detailed than KEGOC expected or ever used in their old system planning software. At the same time, DlgSILENT did not expect that such data was not readily available. Therefore, data collection, translation from Russian, and verification took longer than initially planned.

Extension 2 from 30 June to 31 December 2018: The second TA extension was also caused by the delay in data collection. In particular, the Ministry of Energy was requested to provide locations for the potential renewable energy generation sources by region. This information was crucial to analyze the impact of the renewable energy generation on each regional grid and, later, on its integration into the national grid. The Ministry of Energy was delayed in providing such information because, during this period, the ministry was preoccupied with the introduction of a new modality to solicit renewable energy generation projects—i.e., replacing feed-in tariffs with reverse auctions.

Extension 3 from 31 December 2018 to 30 June 2019: KEGOC, for several times, changed major input assumptions such as adding new transmission assets, and changing power and capacity trading arrangements with interconnected countries. This required redesigning of the model and simulations analysis.

#### Technical Assistance Assessment Ratings

Criterion	Assessment	Rating
Relevance	The TA provided tools, knowledge, and skills to KEGOC staff to assess the impact of the integration of renewable energy generation into the Kazakh national grid, and quickly identify counterbalancing measures. As a result, approval of new renewable energy generation projects resumed.	Highly relevant
Effectiveness	The TA outcome and outputs in the design and monitoring framework (Appendix 1) were attained. PowerFactory became the primary system planning platform for KEGOC, not only for the integration of renewable generation sources, but for any transmission system planning matters. In addition to the original scope, the TA provided valuable recommendations on how to improve operational efficiency of the power system, which KEGOC is currently considering to implement. Training targets were also exceeded.	Highly effective
Efficiency	Underestimated readiness of the required large amount of detailed data, translation needs, and several external factors resulted in three extensions of the TA; thus, it is rated <i>less than efficient</i> .	Less than efficient
<b>Overall Assessment</b>	Overall, the TA is still assessed <i>highly successful</i> as it is rated <i>highly relevant</i> and <i>highly effective</i> , albeit <i>less than efficient</i> .	Highly successful
<b>Sustainability</b>	PowerFactory became the primary system planning platform for Kazakh power system operator, KEGOC. KEGOC's system planning skills and capacity, particularly with regard to integration of renewables, have been substantially increased. In 2020, KEGOC plans to procure additional PowerFactory licenses.	Most likely sustainable

#### Lessons Learned and Recommendations

Design and/or planning	The TA was designed adequately. However, future TA projects, with similar technical complexity, should allocate more time and resources for the preparatory phase such as data collection and translation. The planning phase should also consider that state-owned enterprises are often influenced by political decisions going beyond a specific sector and, therefore, additional time is necessary.
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Implementation and/or delivery	Previously, other development agencies tried to introduce modern power system planning tools in Central Asia, but all of them failed. <sup>4</sup> Such technically complex systems are used by multiple departments of the system operator. From a sustainability perspective, it is important to identify the most suitable system, and allocate sufficient resources for user licenses and training activities.
Management of staff and consultants	This was a technically complicated TA involving modern technologies that were new for Kazakhstan and the entire Central Asian region. KEGOC was also the first-time ultimate beneficiary of an ADB TA. The TA required close supervision from ADB to ensure smooth cooperation between the executing agency and the consultants. It is also important for ADB to promptly make necessary changes to the consulting team. DlgSILENT GmbH's team leaders were replaced twice. The first team leader resigned from the company due to his dependent's illness. The second team leader was replaced by the firm's Managing Director due to the increasing complexity towards the last phase of the TA.
Knowledge building	The recommendations of the final report are particularly important for the former Soviet Union countries that have similarly designed power systems and operational practices. Following the Kazakh experience, in 2019, the "Power the Future" program of the United States Agency for International Development provided two PowerFactory licenses each to Kyrgyz Republic, Tajikistan, and Uzbekistan.
Stakeholder participation	The TA was technically complex and relevant only to the energy sector policy maker (Ministry of Energy) and power system operator (KEGOC).
Partnership	Not applicable. The TA did not involve agencies other than the executing agency, KEGOC, and the consultant and/or contractor. The TA was financed by the Clean Energy Fund under the Clean Energy Financing Partnership Facility (footnote 1).
Replication and/or scaling up	The TA provides technical analysis and conclusions that would be interesting for any country that is keen to develop power generation from renewable energy sources.
Post-TA financial resource	Since PowerFactory became the primary system planning platform, KEGOC is planning to procure additional licenses and modules from DlgSILENT in 2020 using its own resources.

#### Follow-up Actions

In 2020, the final report of the TA consultants will be published as a knowledge product (Technical Study) and disseminated to other countries that are keen to develop renewable energy generation. Similar TA could be offered to other Central or South Asian countries.

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<sup>4</sup> For example, in 2008, the United States Agency for International Development funded the Regional Energy Markets Assistance Program, which procured similar system planning software PSS@E for system operators in Kazakhstan, Kyrgyz Republic, Tajikistan, and Turkmenistan; and for the Coordination and Dispatch Center in Uzbekistan. However, none of these entities ever used this software due to absence of a Russian language interface and very limited number of user licenses (only one license was provided).

## DESIGN AND MONITORING FRAMEWORK

<b>Impact</b> Electricity supply from renewable energy sources in Kazakhstan increased to 3% (in kilowatt-hour) by 2020.		
<b>Results Chain</b>	<b>Performance Indicators with Targets and Baselines</b>	<b>Achievements</b>
<b>Outcome</b> Transmission system operator's capacity for planning and modeling of the integration of variable power generation sources into the Kazakh power system established.	a. Modern transmission planning system operational by 2018	Achieved. PowerFactory became the primary system planning platform for KEGOC for integration of renewable generation sources and general transmission system planning (included in KEGOC 2019 draft annual report).
<b>Outputs</b> 1. KEGOC's transmission system planning and operations staff trained on modern system planning tools  2. KEGOC's system planning tools improved  3. A list of transmission grid reinforcement projects necessary to integrate electricity generated from renewable energy sources prepared	1a. At least two workshops to train 24 transmission system planning and operations staff, of which 30% are female, completed by 2017 (2016 baseline: NA)  2a. Power system modeling, analysis, and simulation software installed at KEGOC by 2017 (2016 baseline: NA)  2b. Kazakh transmission grid converted or built into a new platform by 2017 (2016 baseline: NA)  3a. Power system simulations and analyses completed by 2018 (2016 baseline: NA)	1a. Achieved. By October 2017, eight trainings on PowerFactory software were conducted for 30 KEGOC electrical engineers and staff; 21 (70%) of 30 training participants were women. Additional trainings and internship sessions were conducted for 35 staff from the regional branches and the National Dispatch Center of KEGOC by April 2018.  2a. Achieved. In total, 68 licenses of various modules of the power system planning software, PowerFactory, were installed in different departments of KEGOC by May 2017.  2b. Achieved. Kazakh power grid was built in PowerFactory and passed the acceptance test in August 2017.  3a. Achieved. Various power system analyses and simulations completed. A 10-year transmission expansion plan, listing projects with total value of US\$1.4 billion, prepared.

**Actual Key Activities with Milestones**

**1. KEGOC’s transmission system planning and operations staff trained on modern system planning tools**

- 1.1 Training needs assessment completed by March 2017.
- 1.2 Eight training workshops on modern transmission system planning tools for integration of renewable energy generation sources completed in September–October 2017. Additional trainings and internship sessions conducted in March–April 2018.

**2. KEGOC’s system planning tools improved**

- 2.1 All licenses for a new planning software procured by August 2017.
- 2.2 All hardware and backup systems procured by July 2017.
- 2.3 All hardware and software installed by August 2017.
- 2.4 Kazakh power system converted into a platform by September 2017.

**3. A list of transmission grid reinforcement projects necessary to integrate electricity generated from renewable energy sources prepared**

- 3.1 Simulations and power system analyses commenced by September 2017

**Actual Inputs**

Asian Development Bank: \$1,000,000 (Clean Energy Fund under the Clean Energy Financing Partnership Facility)<sup>a</sup>

Government: \$400,000 (estimated in-kind contribution from KEGOC as counterpart support in the form of equipment and backup systems for the installation of new planning software, taxes, counterpart staff, office space and furniture, internet, and telecommunication).

KEGOC = Kazakhstan Electricity Grid Operating Company, NA = not applicable.

<sup>a</sup> Financing partners are the governments of Australia, Norway, Spain, Sweden, and the United Kingdom.

Source: Asian Development Bank.

## TECHNICAL ASSISTANCE COST

**Table A2.1: Technical Assistance Cost by Activity**  
(\$'000)

Item	Amount		
	Original	Revised	Actual
1. Consultants	543.0	543.0	540.5
2. Software and associated licenses	410.0	410.0	410.0
3. Training, seminars, and/or conferences	4.0	4.0	20.0
4. Vehicle Rental	10.0	0.0	00.0
5. Miscellaneous administration and support costs	10.0	20.0	00.0
6. Contingency	23.0	23.0	0.0
<b>Total</b>	<b>1,000.0</b>	<b>1,000.0</b>	<b>970.5</b>

Source: Asian Development Bank estimates.

**Table A2.2: Technical Assistance Cost by Financier**  
(\$'000)

	Clean Energy Financing Partnership Facility	Kazakhstan Electricity Grid Operating Company	Total Cost
1. Original	1,000.00	400.00	1,400.00
2. Actual	970.51	400.00	1,370.51
3. Unused	29.49	0.00	29.49

Source: Asian Development Bank estimates.