CASE STUDY

How Uzbekistan is Becoming a Solar Energy Powerhouse

Uzbekistan is capturing solar energy and knowledge with its first large-scale solar power plant and a new solar energy institute.

Overview

In the Republic of Uzbekistan, increasing demand and aging thermal power plants contribute to growing energy deficiencies.

Solar energy is a sustainable option for bridging the gap that, until recently, has been overlooked. Solar development in Uzbekistan was limited to academic research since its independence in 1991.

Now, Uzbekistan aims to become a regional hub for solar energy.

With assistance from the Asian Development Bank (ADB), Uzbekistan established the International Solar Energy Institute, developed a road map for solar energy development with action plans and enabling policies, and a pipeline of solar projects. Perimeter fencing and construction of access road, transmission line, and other auxiliary facilities are ongoing.

Through ADB financing, Uzbekistan is building its first large-scale solar power plant even as it continues to increase research and institutional capacities for the finance, design, implementation, operation, and maintenance of this modern infrastructure. The 100-megawatt solar power plant will be among the world's largest photovoltaic power plants, with a gross annual output of at least 159 gigawatt-hours.

Project snapshot

Dates	• **2013:** Loan approval • **2016:** Design-build-operate contract for power plant signed • **2018:** Expected date of commissioning
Cost	• **US$ 310 million:** Total project cost estimate • **US$ 110 million:** Loan amount
Institutions and Stakeholders	**Financing** • Asian Development Bank **Executing agency** • JSC Uzbekenergo **Others** • Republic of Uzbekistan: Borrower

Challenges

Uzbekistan, one of the world's most energy- and carbon- intensive countries, relies on fossil fuels to supply 89% of its electricity demand. Hydropower supplies 11%. More than 50% of its thermal power plants were built before 1982, and 10% were built after 1997. Deterioration of the country's aging thermal power plants and higher energy demand have contributed to a growing electric power deficiency in Uzbekistan.

A widening gap between supply and demand

Uzbekistan needs to tap alternative sources of energy. Projections suggest that its oil reserves will last only until 2026, natural gas reserves could be depleted by 2045, and coal reserves may only be available until 2065.

Uzbekistan's vast idle land area exposed to high levels of solar irradiance provides an opportunity for solar power to help address the country's energy security concerns. Uzbekistan's President Islam Karimov issued Presidential Decree 4512 (1 March 2013), mandating the creation of advanced solar industries to support the country's goalsof becoming an international knowledge and technology hub for solar energy and attaining a 21% renewable energy capacity by 2031, including at least 4 gigawatts of solar capacity.

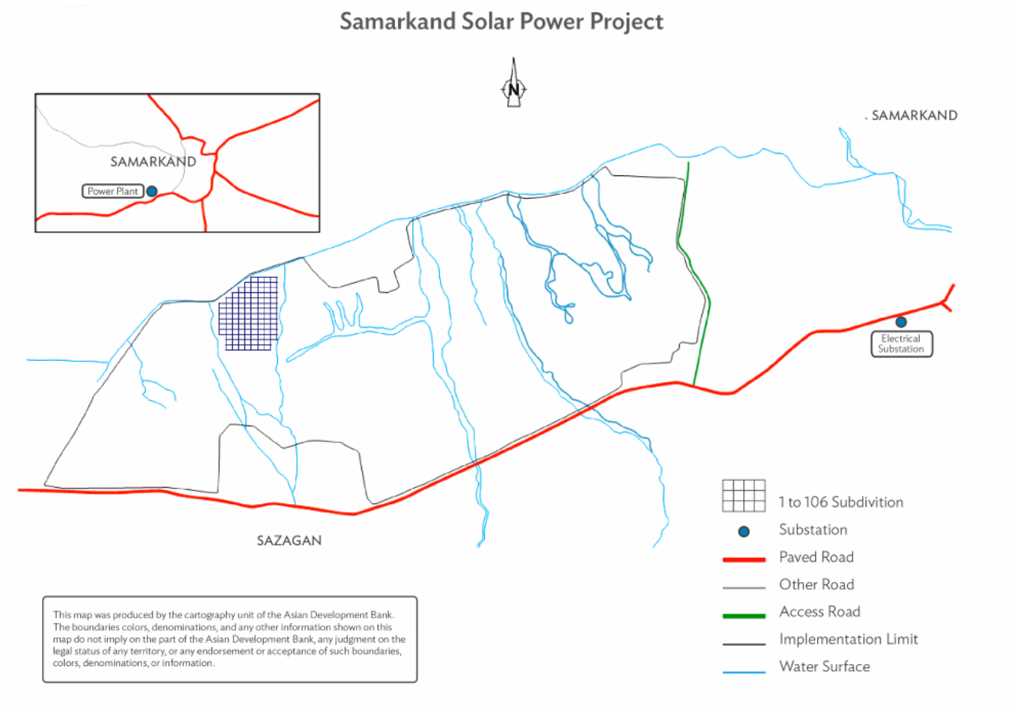
Although Uzbekistan was known for research and development of the solar furnace in 1983, when it was still part of the former Soviet Union, no significant change has occurred since it gained independence in 1991. Solar energy development was limited to academic research.

Solutions

Uzbekistan sought technical and financial assistance from ADB to develop the country's solar energy sector and build its first solar power plant.

ADB helped Uzbekistan in three areas:

- create the International Solar Energy Institute (ISEI), which was envisioned as the region's solar research and knowledge hub;
- develop a road map that detailed action plans, enabling policies, and a pipeline of solar projects; and
- develop the 100-megawatt (MW) Samarkand Solar Power Project, the region's first solar photovoltaic power plant.



Source: ADB. 2014. Uzbekistan: Solar Power Development. Report presented at the 7th Meeting of the asia Solar Energy Forum. Seoul, Republic of Korea. 15–17 october 2014

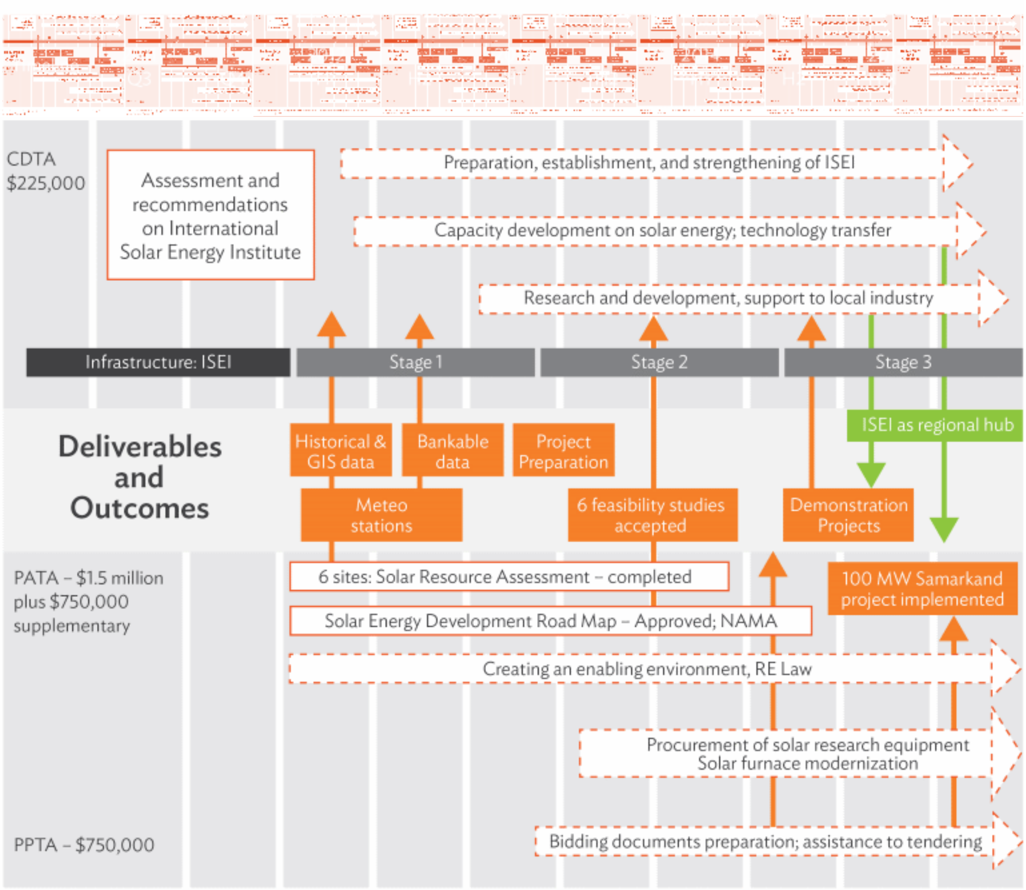
Strengthening solar energy knowledge and research capacity

ADB used technical assistance to help Uzbekistan expand its institutional capacity for solar energy (Figure 1). Designated as executing agency for the first technical assistance, the Scientific-Production

Association on Solar Physics (Physics Sun) also designed the International Solar Energy Institute, including its vision, organization structure, mandates and responsibilities, and institutional charter. The institute is envisioned as a regional hub for solar knowledge and technology and the focal point for solar technology in Uzbekistan and Central Asia.

ADB's second technical assistance conducted feasibility studies to create a pipeline of solar projects and also developed the solar road map. It is enhancing solar research by modernizing the solar furnace and heliostat fields, designing a photovoltaic bed facility and certification laboratory, and procuring relevant equipment.

Figure 1: ADB Assistance to Uzbekistan Solar Energy Development – Synergy, Outcomes, and Status



ADB = Asian Development Bank, giS = geographic information system, iSEi = international Solar Energy institute, MW = megawatt.
Source: Cinderella Tiangco, ADB

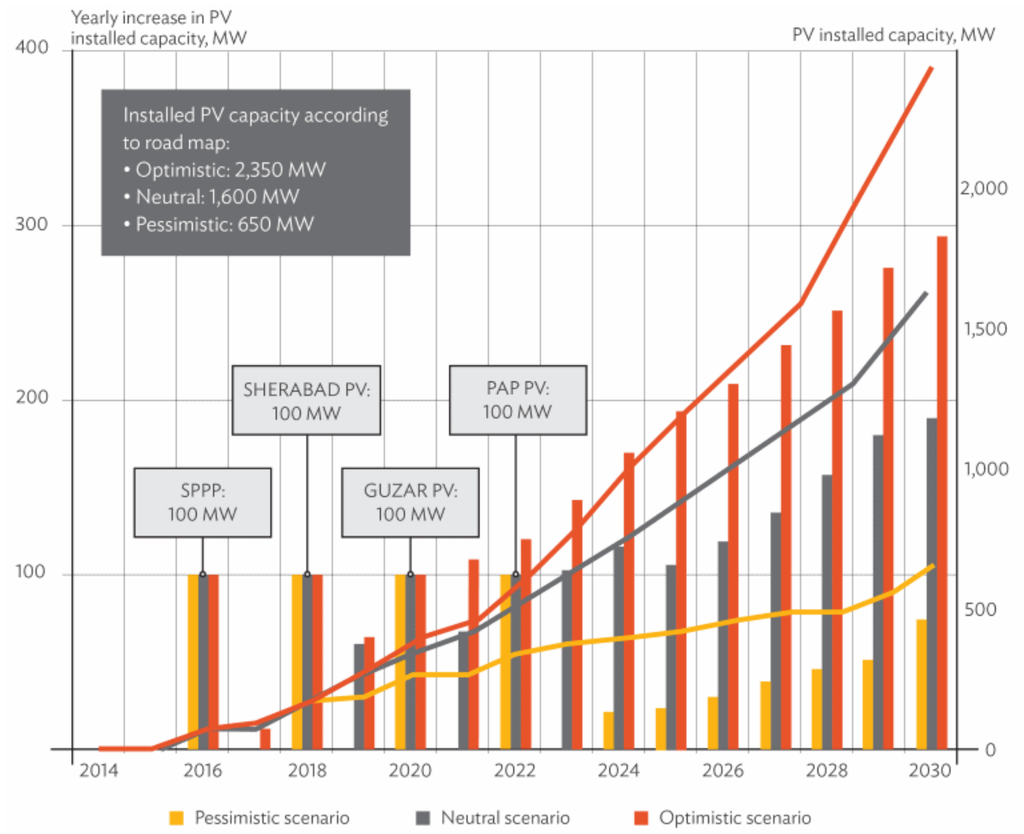
Establishing the International Solar Energy Institute

The institute was established on 1 March 2013. Its director and deputy director were brought to countries with leading solar expertise and technologies for training and networking for future collaboration. Physics Sun retained its mandate to operate the solar furnace and conduct basic research on solar energy to differentiate itself from the institute. ADB helped the institute obtain funding for the photovoltaic test bed facility in Namangan, a city in eastern Uzbekistan.

Creating a road map for solar energy development

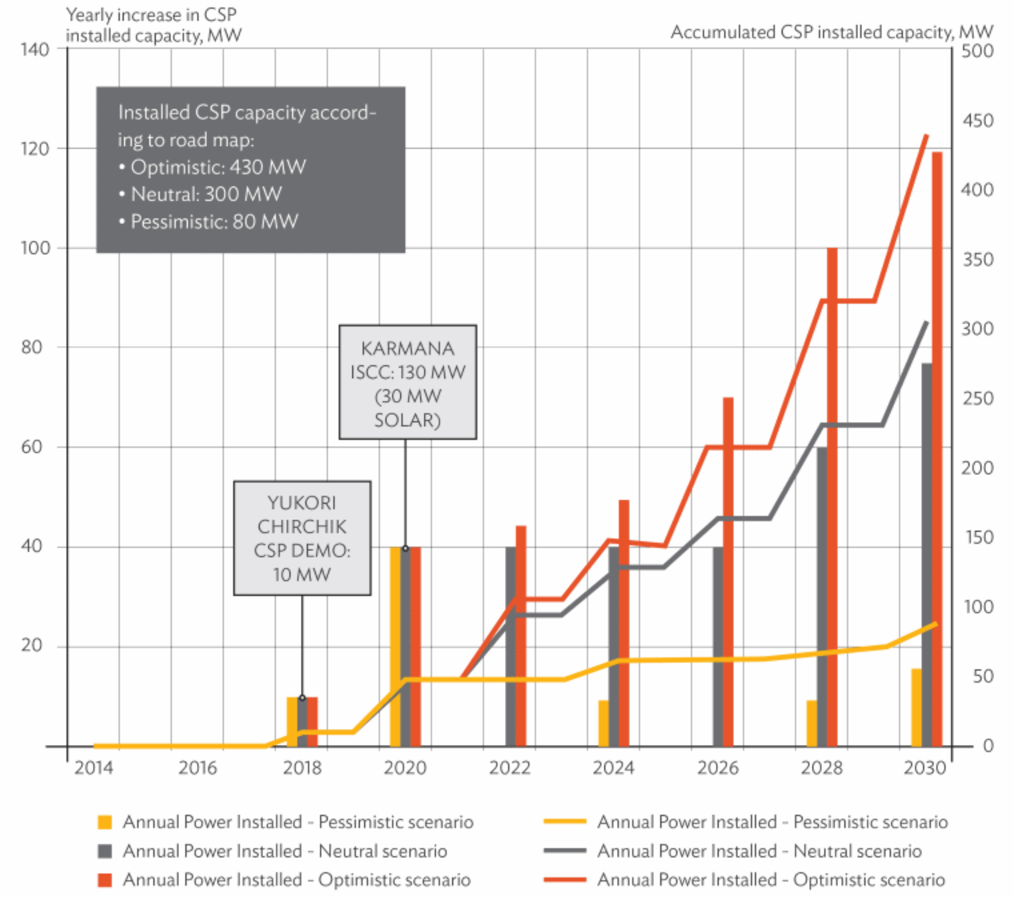
ADB's second technical assistance helped formulate a road map with multi-agency action plans and a pipeline of solar projects to enable the government of Uzbekistan to reach its solar targets (Figure 2). The pipeline of projects, including forecasted photovoltaic and concentrating solar power installed capacity (the two major solar power technologies), was created based on solar resource assessments and mapping with geographical information systems layers (Figure 3). Requirements for solar power development including investments, irradiation, land, water, labor, and other inputs were assessed.

Figure 2: Photovoltaic Technology in Solar Roadmap



CSP = concentrating solar power, MW = megawatt, PV = photovoltaic.
Assumptions:
– neutral: Uzbekistan's renewable energy plus conventional = 100% of Conservative Scenario of consumption in 2030
– optimistic: installed PV capacity reaches the 15% of installed capacity (grid stability)
– Pessimistic: Uzbekistan's renewable energy plus conventional = 95% of Conservative Scenario of consumption in 2030
– PV/CSP (Power) = 5 (Following iEa world forecast): Quadratic growth
Source: Cinderella Tiangco, ADB

Figure 3: Concentrating Solar Power Technology in Solar Roadmap



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Source: Cinderella Tiangco, ADB

Selection of suitable project sites

Solar power plant sites must satisfy certain criteria to ensure optimum output at lowest cost (i.e., irradiation levels; size and topography; availability of water, transmission lines, and other resources; and proximity to load centers). It is necessary to measure on-site solar resources to determine the potential capacity and the optimum plant site corresponding to the chosen technology. To determine the most suitable technology for Uzbekistan, ADB's second technical assistance assessed solar irradiance at six meteorological ground stations near potential sites. Direct normal irradiance and global horizontal irradiance were measured at these stations for 12 months.

Direct normal irradiance or DNI is solar radiation that travels in a straight line from the sun at its current position in the sky. Global horizontal irradiance or GHI is the total amount of shortwave radiation received from above by a surface horizontal to the ground.

DNI is correlated with concentrating solar power or CSP potential, while GHI determines photovoltaic or PV potential. CSP uses mirrors to reflect sunlight and use solar heat to generate electricity. PV or solar cells convert sunlight (photons) directly into electricity.

The assessment identified the suitable areas for both CSP and PV solar energy power plants.

Land availability is a critical part of solar project development. The total area of available land generally defines the capacity of the solar power plant. CSP plants require more land than PV plants, due to turbines, generators, steam condensers, and other related equipment and infrastructure. Location is also important because it determines workforce availability and cost of transport infrastructure, grid connection, and water supply. In Uzbekistan, about 3.8 million hectares of land meet the minimum technical requirement for hosting solar energy.

Water supply is another important factor. PV power plants require water to regularly clean PV panels for optimum efficiency. CSP plants, which transform thermal energy to electricity, need water to clean, produce steam, and cool the steam condensers. Lacking nearby water resources, power plants must use a costly dry-cooling method. The cost of both water supply and infrastructure needed to connect the plant to a water source affect the total operating and maintenance costs.

Selection of solar power plant technology

PV technology converts solar energy to direct current electricity using a semiconductor layer, or PV cell. A PV system contains interconnected cells that form a PV module, and a set of additional application-dependent components (e.g., inverters, batteries, electrical components, and mounting systems). Commercial PV modules consist of wafer-based crystalline silicon or thin films. Installation of PV systems uses either fixed-tilt structures or one- and two-axis tracking system structures.

CSP technology uses parabola-shaped mirrors to concentrate incoming direct solar radiation on a focal line. Because it uses only direct solar irradiance, CSP technology works best in areas that enjoy clear skies almost all year round.

After conducting due diligence to assess the resources and requirements of the different types and configurations of solar power plants in the six study areas, the project determined that Uzbekistan’s first solar power plant will be a 100 MW crystalline, fixed-tilt tracking, PV power plant in the Pastdorgom and Nurabad districts of Samarkand province, which is in the central part of the country. This option offered the simplest technology, required lower investment, simplest maintenance, least water resources, and posed the least risk. The level of institutional capacity was a significant factor in selecting PV with fixed-tilt tracking over other configurations of PV and CSP technologies.

Capacity development and workforce

Forecasts suggest a need for almost 1,200 PV professionals in 2015. Uzbekistan lacks sufficiently trained people to cover this demand and needs a specialized training program for engineers. Therefore, the project conducted institutional capacity building to produce 60 local solar experts to operate the solar power plant. More intensive and comprehensive capacity building will be carried out during the implementation phase.

Numbers and facts

100-megawatt	solar photovoltaic power plant
At least 159	gigawatt-hours gross annual output
Location	Pastdorgom and Nurabad districts of Samarkand province
About 1,200	solar PV professionals needed

Results

Foundation laid for Uzbekistan’s solar energy goals

With assistance from ADB, Physics Sun and the International Solar Energy Institute prepared and submitted the Uzbekistan Solar Energy Development Roadmap for presidential approval.

The road map details the country’s strategies to modernize, upgrade, and rehabilitate the electric grid in preparation for projected electricity generation and demand. It also specifies plans for building solar energy-related capacity in different sectors (e.g., financial and local industry) and centers for excellence that will initiate educational and training programs for potential solar energy experts. The road map also includes plans to develop build-operate-transfer and design-build-operate agreements to alleviate state-owned Uzbekenergo investment.

The establishment of the solar energy institute and road map are Uzbekistan’s initial steps in attaining energy security and becoming an international knowledge and technological hub for solar energy. Collaboration and consultation with all stakeholders will continue until the necessary enabling policies have been enacted and the industry starts to develop.

New job opportunities and increased power supply

Completion of the power plant will directly benefit Samarkand province. Construction will generate new jobs, 70% of which can be filled by locals. Demand for PV professionals will increase because the ratio between installed capacity of PV and CSP will reach 5:1 in 2030. Potentially, Samarkand’s industrial hub will create a new industry for PV power plants. Moreover, additional energy supply will stimulate economic activity. Current supply suppresses demand and constrains the growth of small and medium-sized enterprises.

Nationally, the project can improve the sustainability of Uzbekistan’s energy supply and increase the generation of renewable energy. The estimated gross output of the Samarkand solar energy power plant is estimated at 159 gigawatt-hours per year. Solar energy development will also lead to fuel savings, reduced fuel imports, and lower carbon emissions. To enable a match between suitable carbon financing and support for capacity building, a Nationally Appropriate Mitigation Action is undergoing development based on the solar energy development road map, for inclusion in the United Nations Framework Convention on Climate Change.

Lessons

A road map is an effective planning and communication tool.

A road map helps identify barriers and risks to objectives or goals. It also proposes actions and sets priorities to reach goals and targets taking into account the needs of main stakeholders. By itself, the road map preparation process verifies potential and identifies strengths and weaknesses. It also provides growth scenarios, analysis, and validation, and reviews the availability of natural resources.

Uzbekistan’s journey toward its goals of attaining energy security through renewable energy and becoming an international knowledge and technology hub for solar energy has just begun. Through the development and use of a road map, all stakeholders will understand Uzbekistan’s vision for solar industry, enabling the country to maximize opportunities and speed the solar power development process.

Stocktaking of capacity and resources is key to success of project.

Although solar power is not a new concept, it is new in Uzbekistan. Conducting comprehensive due diligence of the country’s capabilities and resources enables the systematic and sustainable development of solar technology in the Uzbekistan context.

Resources

ADB. 2015. *Knowledge and Power: Lessons from ADB Projects*. Mandaluyong City, Philippines.

ADB. 2013. *Report and Recommendations of the President to the Board of Directors: Proposed Loans to the Republic of Uzbekistan for the Samarkand Solar Power Project*. Mandaluyong City, Philippines.

ADB. Uzbekistan: Samarkand Solar Power Project

Related links

Toward a Sunny Future? Global Integration in the Solar PV Industry

Policy Brief: Harnessing the Sun and Wind in Indonesia

Solar Photovoltaic Technology Basics

Top 10 Things You Didn't Know About Concentrating Solar Power

Meet the expert

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Cindy Tiangco has more than 20 years of experience in energy. She develops innovative clean energy projects in Central and West Asia. She holds a doctorate in Mechanical Engineering from Australia’s University of New South Wales, a master’s degree in Energy Technology from Thailand’s Asian Institute of Technology, and a bachelor’s degree in Electrical Engineering from Silliman University, Philippines.

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