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Review on the Solar Energy Supply Project in Uzbekistan and Policy Recommendation

Abstract. *This paper seeks to review the KSP sponsored project - the national strategy for solar energy system supply and fostering the related industry clusters. Then try to present some additory policy recommendations regarding the project. In recent years, Uzbekistan has been diversifying the energy mix and developing renewable energy sources to present some solutions for energy deficits and climate change. Especially since 2016, Uzbekistan has significantly focused its attention on developing renewable energy resources and, in particular, solar energy. In this regard, Uzbekistan has been applying to the Knowledge-Sharing Project (KSP) coordinated by the Korean government for having know-hows of energy supply and developing renewable energy sectors of Korea. In conclusion, this paper presents some recommendations – such as that - it should relate the recommended supply of solar power generation power to the industrial complex in connection with Special Economic Zones (Navoiy, Angren, Jizzax).*

Keywords and expressions: *Knowledge Sharing Program (KSP), Korea, Uzbekistan, solar energy potential, PV (photovoltaic) station, Ministry of Energy of Uzbekistan.*

Аннотация. *Ушбу мақола «Билим алмашиш лойиҳаси» (KSP) ҳомийлигидаги лойиҳа – қуёш энергияси тизимини таъминлаш ва тегишли саноат кластерларини ривожлантириш миллий стратегиясини таҳлил қилишга қаратилган. Шунингдек, лойиҳа бўйича қўшимча сиёсат тавсияларини тақдим этишга ҳаракат қилинган. Сўнгги йилларда Ўзбекистон энергия тақчиллиги ва иқлим ўзгаришига қарши баъзи ечимларни тақдим этиш учун энергия мажмуасини диверсификация қилмоқда ва қайта тикланадиган энергия манбаларини ривожлантирмоқда. Айниқса, 2016 йилдан буён Ўзбекистонда қайта тикланадиган энергия манбаларини, хусусан, қуёш энергетикасини ривожлантиришга жиддий эътибор қаратилмоқда. Шу муносабат билан Ўзбекистон Корея ҳукумати томонидан мувофиқлаштирилган «Билим алмашиш лойиҳаси» (KSP)га Кореянинг энергия таъминоти ва қайта тикланадиган энергия соҳаларини ривожлантириш бўйича ноу-хауларга эга бўлишга ҳаракат қилинмоқда. Хулоса қилиб айтганда, ушбу мақолада махсус иқтисодий зоналари (Навоий, Ангрен, Жиззах)даги саноат мажмуаларига қуёш энергияси ишлаб чиқариш қувватини жорий этиш билан боғлиқ бўлган баъзи тавсиялар келтирилган.*

Таянч сўз ва иборалар: *Билим алмашиш лойиҳаси (KSP), Корея, Ўзбекистон, қуёш энергияси салоҳияти, ФВ(фотоволтаик) станция, Ўзбекистон Энергетика вазирлиги.*

Аннотация. *В этой статье делается попытка рассмотреть проект, спонсируемый KSP, - национальную стратегию по поставке солнечной энергии и развитию соответствующих отраслевых кластеров. Затем представлены некоторые дополнительные политические рекомендации относительно проекта. В последние годы Узбекистан занимается диверсификацией энергетического баланса и развитием возобновляемых источников энергии, чтобы предложить некоторые решения в связи с дефицитом энергии и изменением климата. Особенно с 2016 года Узбекистан значительно сосредоточил свое внимание на развитии возобновляемых источников энергии и, в частности, солнечной энергетики. В связи с этим, Узбекистан подал заявку на участие в Проекте по обмену знаниями (KSP), координируемом правительством Кореи, для получения ноу-хау в области энергоснабжения и развития секторов возобновляемой энергетики в Корее. В заключение в этом документе представлены*

некоторые рекомендации, в частности, проект должен связать рекомендуемую поставку солнечной энергии с промышленным комплексом с особыми экономическими зонами (Навои, Ангрен, Джизак).

Опорные слова и выражения: *Программа обмена знаниями (KSP), Корея, Узбекистан, потенциал солнечной энергии, фотоэлектрическая станция, Министерство энергетики Узбекистана.*

I. Introduction

Uzbekistan aims to maximize savings through rational use and application of clean energy technology, integration of energy efficiency into national planning, improvement of sector performance through commercializing utility operations, the attraction of private sector participation, and increase of energy exports on a commercial basis.

Uzbekistan is the most populous country in Central Asia. Despite it being the biggest electricity producer in the region, the country's power sector is highly inefficient because most of the power generation facilities are from the Soviet Union era. Since 2016 Uzbekistan has significantly focused its attention on developing renewable energy resources and, in particular, solar energy, in a bid to diversify its energy balance and reduce its dependence on gas. With this regard, Uzbekistan has been applying to the Knowledge-Sharing Project (KSP) coordinated by the Korean government for having know-hows of energy supply and developing renewable energy sectors of Korea.

As known, Korea is well known among developing countries in South Asia and Central Asia as well for its (KSP). This is the symbol of Korea's public diplomacy which is to share Korea's previous economic development experiences to other countries and ultimately seek for mutual prosperity of all. Since 2004, Korea's development experience and knowledge have been provided to recipient countries more than 70 countries around the world through KSP.

The KSP project has been operated under the supervision of the Ministry of Economy and Finance by designating an organization with expertise in each sector as the project management/execution organization. The Korea Development Institute (KDI) for economic and social policies, the Export-Import Bank of Korea(EXIM) for the construction/infrastructure sector, and the Korea Trade-Investment Promotion Agency (KOTRA) for the industrial trade and investment sector.

So far, Uzbekistan has been one of the top beneficiaries when it comes to the conducting policy advisory projects by the Korea Development Institute and the Export-Import Bank of Korea almost every year since 2010. During 2020-2021, EXIM bank has promoted the 2020/2021 EIPP (Economic Innovation Partnership Program, EIPP) related to developing the Angren City, a special economic zone, in Uzbekistan: 'Establishment of national big data promotion strategy', 'Establishment of master plan for construction and agricultural machinery industry cluster fostering policy', 'Establishment of master plan for water and resource circulation smart city based on advanced technology', 'Smart logistics master plan establishment', and 'National strategy establishment project for supplying solar

energy in Uzbekistan and nurturing related industries'. All these projects are closely related to developing an industrial city with equipped by high-technology. As a project in line with the industrial and economic innovation strategy of the Uzbekistan government, a project feasibility study for the innovative project mentioned centered on Angren city, a step-by-step roadmap, and discovery of follow-up related projects are being discussed.

In this paper, one of those mentioned projects - the national strategy for solar energy system supply and fostering the related industry clusters will be reviewed and try to present some policy recommendations regarding this project. The main purpose of this paper is, first, to analyze the current challenges that Uzbekistan now faces in the energy mix and supply. Then, secondly, it explores the Uzbekistan's solar energy potentials and current situation. This part goes to the Chapter II and the information and resources regarding solar energy of Uzbekistan in this chapter are mainly referred to the project's report.[1] Finally, this paper will conclude by reviewing whether the policy recommendation provided by the project is 'suitable' and 'visible' for Uzbekistan's counterpart, so this kind of policy review could help building further steps for cooperation between Korea and Uzbekistan in the future.

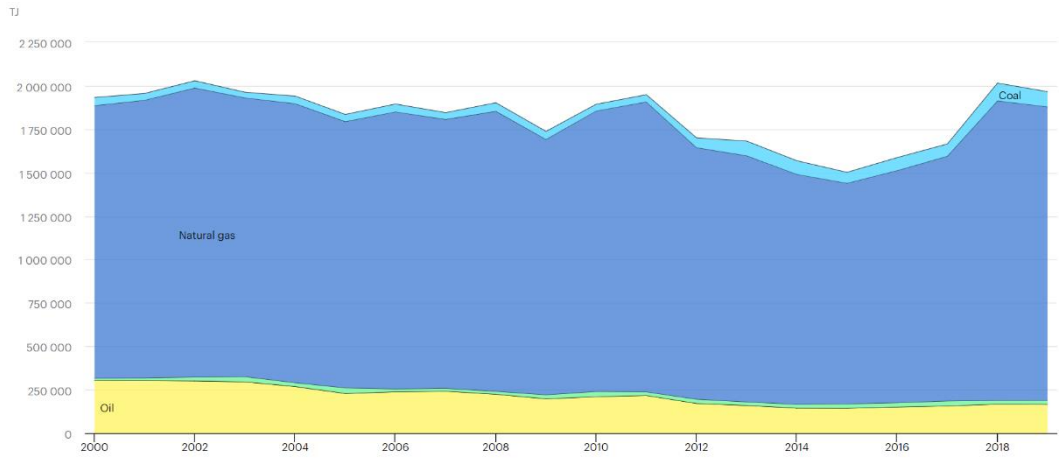
II. Power Mix and Challenge of Energy Supply in Uzbekistan

Uzbekistan, which has significant solar energy potential, prepares a solar energy expansion plan to convert the current fossil fuel-centered energy contribution. The significance of energy transition mainly to renewable energy is highlighted to respond to climate change worldwide. Therefore, Uzbekistan's energy transition to new renewable energy is essential to respond to climate change through reducing GHG(green house gas), coping with increased energy demand, and strengthening energy security. For this reason, Korea is also contributing to solar energy generation and GHG reduction by introducing various incentives and programs related to solar energy.[2]

As well known, Uzbekistan owns plenty of natural resources such as natural gas, oil, coal, and gold, and uranium. In case of her gas reserves and crude oil reserves, she has over 1.2 trillion m^3 and 100 million tons respectively. For natural gas, it ranks 11th in the world for mining and 14th for reserves, and for uranium it is 6th for mining and 7th for explored reserves.[3] As of 2019, Uzbekistan's total energy supply was 47,07 mtoe, of which fossil fuels accounted for the most, with natural gas supplying over 85% (see <Fig.1>).

<Fig.1 Total energy supply (TES) by source, Uzbekistan 2000-2019>[4]

[1] (2020/21 EIPP) Final report on the national strategy establishment to supply solar energy and foster related industries in Uzbekistan.
[2] (2020/21 EIPP) Final report on the national strategy establishment to supply solar energy and foster related industries in Uzbekistan, p. i.
[3] IEA, UZBEKISTAN, https://www.iea.org/reports/uzbekistan-energy-profile.
[4] IEA, Uzbekistan, Total Energy Supply, https://www.iea.org/countries/uzbekistan.



Unfortunately, the Uzbekistan government's energy stockpile will gradually move to a deficit due to the aging of energy production facilities and lack of new investment. In addition, gas production at Uzbekistan's oil refineries is declining, with the utilization rate falling below 30% due to aging facilities. However, as energy demand increases, the country acknowledged gas exports might stop after 2025 due to increased gas consumption.[1] Natural gas accounts for a large portion of the energy supply as of 2018 and is used for heating in most regions. Reduced gas supply is poised to cause significant problems in the local energy supply. In addition, energy exports such as oil and gas account for 14.1% of the export sector, which is expected to impact the economy. The government is pushing ahead with the refinery modernization project to solve the depletion of natural gas. Still, in the long term, it is necessary to diversify energy sources and secure sustainable energy sources through renewable energy development.

When it comes to the energy supply, as of 2018, the total installed capacity of power plants in Uzbekistan was 12.8GW, of which thermal power generation accounted for 85.6% and hydroelectric power generation 14.3%. As of 2018, the total power supply was 62,896GWh, of which thermal power generation accounted for 90% of the total power supply in Uzbekistan.[2] Power supply through hydroelectric power accounted for about 9% of the total power supply, but the amount of power generation was small compared to the installed capacity (14%).[3] The installed capacity of renewable energy other than hydroelectric power was relatively insignificant at around 1%, and the generation capacity also appears to be around 1%. Uzbekistan is rich in natural gas, and power generation through natural gas rather than renewable energy is economically more feasible, and so far, it has relied on fossil fuels.

[1] Korea Trade-Investment Promotion Agency, 2020.
[2] Global Data, 'Capacity & Generation' (https://power.globaldata.com/geography/capacityandgeneration/100246?type=Total&Country=Uzbekistan&CountryId=386~259&BaseYear=2000-2020, Mar 25, 2021).
[3] IEA, 'Electricity generation by source'(https://www.iea.org/countries/uzbekistan, March 18, 2021).

According to IEA data, the total power generation capacity of Uzbekistan was 12.8 GW as of 2018, but a local consultant survey indicates that the power generation capacity has recently been expanded to reach 16 GW in 2021. Power plants are concentrated in the capital city, Tashkent.[1] The total installed capacity of the Tashkent power plant is about 6038 MW, accounting for about 38% of the total. However, power plants in Uzbekistan's southern, eastern, and northwestern regions have less power plant capacity than Tashkent and the Republic of Kazakhstan, so an imbalance in power supply between regions is manifested.

In addition to hydroelectric power plants, a 0.75 MW wind power plant in Tashkent and a 0.13 MW PV power plant in Namangan are installed. The currently installed renewable energy power plant capacity accounts for less than 1% of the total. However, the proportion of renewable energy power plants is expected to increase in the future, starting with the construction of 100 MW power plants in Navoi and Samarkand. The government is planning to expand the renewable energy capacity to 16.4GW by 2030 compared to 2019, among which solar energy is 5GW, aiming to secure about 17% of the total installed capacity.

When it comes to the energy demand, population and economic growth rates are the pivotal actors affecting to rising demand. The population of Uzbekistan has steadily increased up to 34.7 million in 2021[2]. The economic growth rate has been consistently above 5% from 2015 to 2018, showing constant growth. In the same period, electricity demand also increased from 47TWh to 57TWh, and the energy demand of Uzbekistan is steadily increasing.

In the future, annual electricity production will maintain a 6-7% growth rate, and national electricity production is expected to increase 1.9 times from 2018 to about 12 billion kWh in 2030. Household energy demand is expected to be 2.1 billion kWh, and industrial energy demand is expected to be 8.5 billion kWh, so it is expected that industrial energy will be needed more than household energy in 2030. Electricity generation capacity should approximately double by 2030 compared to 2019 to stabilize electricity supply and demand. Energy demand is increasing due to population growth and industrial development. Still, it is predicted that the energy stockpile will gradually become insufficient due to the aging of production facilities and lack of new investment[3].

That is why Uzbekistan has been seeking to alternatives to secure her energy supply by introducing renewable energy resources like solar power which is studied as potential enough.

III. Uzbekistan’s Solar Energy Potentials

Uzbekistan ratified the Paris Agreement and adopted a national commitment to reduce GHG emissions per unit of GDP by 10% of the 2010 level by 2030, in 2018. Based on the ‘Strategy on the Transition to the “Green” Economy for the Period

[1] (2020/21 EIPP) Final report on the national strategy establishment to supply solar energy and foster related industries in Uzbekistan, p. 20.
[2] Ibid., p. 25; Worldometers website, 2021.
[3] Ibid., p. 25-26; The Ministry of Energy of Uzbekistan, 2020.

2019-2030', Uzbek government aims to increase the share of Renewable Energy Sources(RES) in total electricity generation to more than 25% by 2030. It also plans to double its energy efficiency indicator, reduce the carbon intensity of GDP, and provide the entire population and all economic sectors with access to modern, inexpensive and reliable energy.

In fact, it is likely to expect that Uzbekistan's considerable RES potential could spur significant development of a green, environmentally friendly economy. The country's total RES potential is 117 984 Mtoe, while its technical potential is 179.3 Mtoe. The main potentials goes to the solar energy (total potential of 51 Gtoe and technical potential of 177 Mtoe). Uzbekistan's solar energy's technical potential is almost four times the country's primary energy consumption. Its sunny and dry climate and geographical location would allow Uzbekistan to use solar energy for a wide range of industrial purposes. Wind energy potential totals 2.2 Mtoe, with 19% technical development possible.[1]

<Tab. 1> Uzbekistan's Renewable energy sources and its potentials[2]

Renewable energy source	Gross potential	Technical potential
Hydropower	9.2 Mtoe	2 Mtoe
Wind power	2.2 Mtoe	0.4 Mtoe
Solar power	50 973 Mtoe	177 Mtoe
Geothermal energy	67 000 Mtoe	0.3 Mtoe
Total alternative energy sources	**117 984 Mtoe**	**179.3 Mtoe**

Currently, energy security, affordability, and efficiency are key priorities of the government's energy strategy, according to the recently published report Uzbekistan Solar Photovoltaic (PV) Power Market Outlook 2018-2027.[3] Uzbekistan is a promising country among CIS states for investors in solar photovoltaic (PV) energy due to its excellent solar irradiation potential and high fossil fuels dependency rate. The government has adopted policy and legal frameworks with clear goals to reduce energy intensity and losses and enhance sector investments and institutional change. According to the Decree of the President of the Republic of Uzbekistan dated №4512 'On measures for further development of alternative energy sources',[4] principal attention is being paid to broader use of solar energy and biogas.

Despite the exceptional solar energy potential, but its current power generation in Uzbekistan seems unfortunately quite marginal so far. A pilot project has been carried out since 2014, and a 130kW pilot-project solar power plant and some small power

[1] Although total geothermal energy potential (67 Gtoe) exceeds that of solar, the underdevelopment of simple and cost-effective technologies to exploit this type of energy limits technical development to only 0.3 Mtoe.

[2] EIA, Uzbekistan's renewable resources, https://www.iea.org/reports/uzbekistan-energy-profile/sustainable-development (accessed 2022-04-12).

[3] Uzbekistan Solar Photovoltaic (PV) Power Market Outlook 2018÷2027.

[4] PRESIDENTIAL DECREE OF THE REPUBLIC OF UZBEKISTAN of March 1, 2013 No. UP-4512, https://cis-legislation.com/document.fwx?rgn=61025 (accessed 2022-03-22).

plants were built in the Pap area of Namangan with no large-scale power plants yet. Hopefully, as pilot projects for large-scale solar energy power plants are in progress up to the present, the large-scale PV power plants will gradually expand. As one of the evidences, Uzbekistan inaugurates first utility-scale 100MW solar power plant. Uzbekistan's President Shavkat Mirziyoyev attends an event to celebrate the 100 MW, Nur Navoi Solar (PV) Project in the Navoi region, Uzbekistan, August 27, 2021.[1] Last year, the Uzbek government last month announced its intent to raise its 2030 solar capacity target from 5 GW to 7 GW as it aims to generate a quarter of its electricity from renewables this decade.[2]

The Ministry of Energy of Uzbekistan plans to install 5GW of PV power plants and 3GW of wind power plants by 2030, as stated in the "Basic Power Supply Plan 2020-2030" announced in 2020. The large-scale renewable energy generation development project is planned entirely as an Independent Power Producer (IPP) development, which intends to increase the renewable energy production capacity to 52% of the total capacity by 2030 (see <Figure 17>). In addition, to expand the solar power plant to 5GW, the government schemes to install 100-500MW PV power plants in the northwest regions of Karakalpakstan and Navoi. In other areas, 50-200MW PV power plants will be installed. Large-scale PV power plants with 300MW or more are expected to stabilize power generation and control maximum load by installing energy storage systems in stages. In addition, according to the approval of the 150,000 small-scale solar energy power plant project, electricity will be supplied using microgrids in island areas, replacing about 4.3% of the total household electricity demand.[3]

Uzbekistan is currently managing PV power plant installation projects. The projects for which bidding has been completed include Scaling Solar 1 (Navoi), Solar 100 (Samarkand), Sheradbod Phase I (Surkhandarya), and Scaling Solar II (Jizzakh, Samarkand) as of the end of 2021.

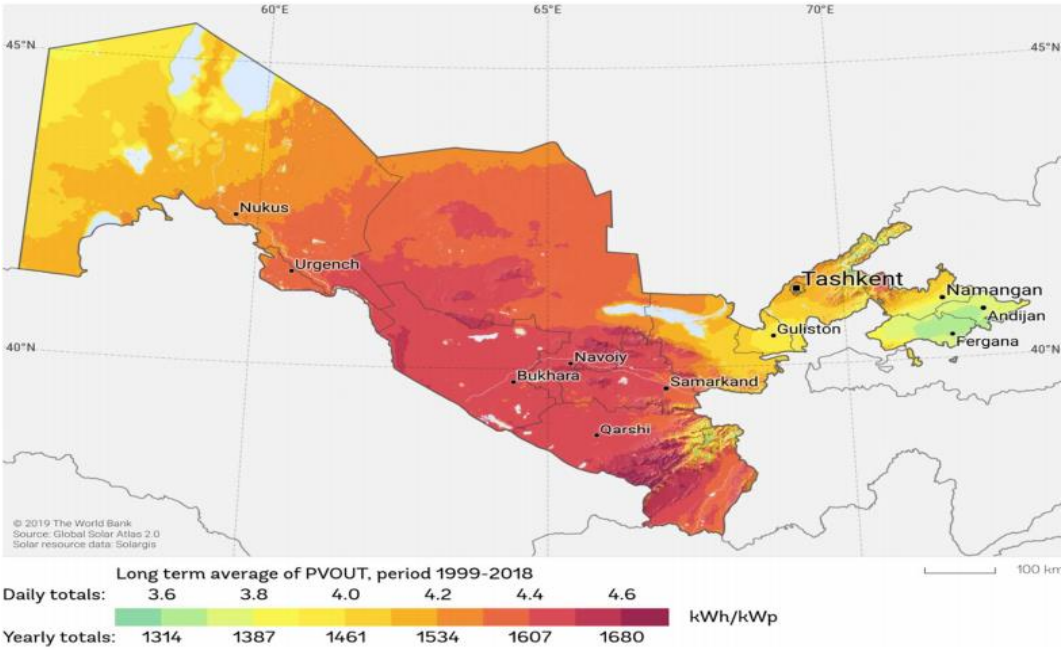
<Fig. 2> Uzbekistan's Solar Energy Potential by Region[4]

[1] Launch of a solar power plant in Navoi will save 80 million cubic meters of gas – Shavkat Mirziyoyev, https://kun.uz/en/news/2021/08/27/launch-of-a-solar-power-plant-in-navoi-will-save-80-million-cubic-meters-of-gas-shavkat-mirziyoyev (accessed 2022-04-16).

[2] Uzbekistan flicks switch on 100 MW Nur Navoi solar plant, https://www.pv-magazine.com/2021/09/01/uzbekistan-flicks-switch-on-100-mw-nur-navoi-solar-plant/ (accessed 2022-04-16).

[3] (The Ministry of Energy of Uzbekistan, 2020a).

[4] Source: World Bank, 'PV Electricity Potential', 2020.



<Figure 2> shows the solar energy potential of each region based on daily average and annual average insolations. The southwestern regions such as Navoi, Bukhara, and Samarkand are affluent in insolation, so PV construction is underway and planned. Thermal power plants had been built centered on Tashkent, so the central and eastern regions have had sufficient power generation within the region. The southwestern region has low power generation, so PV power plants may alleviate the regional power supply imbalance when constructed in the future.

IV. Project's Outcomes and Policy Advice

This project aimed to help strengthening cooperation between the two nations, national energy security and improve citizen's quality of life by sharing South Korea's experience in supplying new and renewable energy. The major structures of following project are; (1) Uzbekistan's solar energy sector status/policy analysis, (2) Deriving implications from South Korea's solar energy experience, (3) The trainings provided for policy practitioners in Uzbekistan, (4) Policy advice for solar power supply and industrial development based on domestic policy.

□ The Policy Analysis on Solar Energy Sector in Uzbekistan

○In Uzbekistan, the incentives for solar energy-related are insufficient and the regulations related to the solar energy power plants operations are not materialized, which are obstacles to future development.

○ The economic feasibility due to the low electricity cost is insufficient, the establishment of resources, technology, and industrial infrastructure are urgently needed to open the monopolized power market structure and develop the solar-related industry.

□ Implications from South Korea's Solar Energy Experiences

○ As in terms of market conditions, there are pros and cons about Uzbekistan's solar market conditions.

-The low electricity rate can be disadvantage for the solar power generation business, but it can be a favorable condition for up to mid-stream sectors such as polysilicon production.

○The renewable energy in Uzbekistan is currently only 1%, so the supply policy and the solar power industry promotion policy should be pursued altogether.

○It is necessary to significantly expand solar power generation using ingot/wafer, cell/module production facilities.

○ It is necessary to promote market opening for the restructuring of the electric power market to expand solar power, induce private sectors to participate in the solar power market, and establish a public institution such as the Korea Energy Organization.

□ The Policy Practitioner Trainings in Uzbekistan

○The training for senior executives is aimed at expanding the solar energy industry by strengthening the capabilities of policy practitioners related to solar energy supply and industry in Uzbekistan, and forming a network among policy practitioners and officials in both countries.

This project provided with some policy suggestions such as establishment of independent ministries in charge of new and renewable energy, governance system for mid- to long-term planning; establishment of insufficient solar energy technology capability and supply chain; establishment of government-funded research institutions, university infrastructure and solar power industry value chain through exchanges with South Korean universities, research institutions; a hybrid solar power plant needs to be built as an energy-water-technology linkage plan in the Aral Sea region.

Also, it suggested that the cooperation between South Korea and Uzbekistan by doing such as an establishment of government-funded research institutions and universities' infrastructures through exchanges among South Korean and Uzbekistan governments, companies, universities, research institutions. It should be noted in the report that it is necessary to respond to climate change in both countries and promote the development of the future energy sectors.

V. Conclusions and Some Additory Policy Recommendations

This article has reviewed already conducted project supported by Korean government's KSP and this KSP has been evaluated quite successfully by the recipient country in sharing Korea's previous experiences and know-hows regarding the project themes. Thus, Korean government and other relevant organizations should take some recommendations by the regional area experts into consideration for further cooperation project in the future. In this way, the KSP as one of the most popular ODA programs by the Korean government is likely to be developed more completely and continued in the long term.

Further promoting this project more activated, it should relate the recommended supply of solar power generation power to the industrial complex in connection with Special Economic Zones (Navoiy, Angren, Jizzax etc.). Furthermore, the policy advice and support in consideration of local circumstances, and training programs for nurturing human resources need to be strengthened.

Uzbekistan has advantages such as low electricity rates and easy obtainment of raw materials, but has disadvantages such as large-scale investment, instability of cash flow, and lack of infrastructure for producing solar energy facilities. Thus, it is necessary to secure investment stability in the solar energy value chain by building other industrial infrastructures for hydrogen, nitrogen, and hydrochloric acid for polysilicon production.

In terms of price competitiveness with Chinese products and difficulties in shipping, it is recommended for the Uzbekistan government to establish a new and renewable energy-related department to solve such risks. Fostering manufacturing and attract foreign companies, large-scale solar power generation facilities are needed to supply eco-friendly energy.

Lastly but not least, to overcome the dire situation in Uzbekistan, the eco-friendly energy supply is important, not only for cooperation with South Korea, but also for attracting investment from global manufacturing companies.

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