Green Silk Road and Belt Economic Initiative and local sustainable development: through the lens of China's clean energy investment in Central Asia

Abstract

This paperexamines how China's renewable energy investment contributes to the Central Asian countries' GHG emission reduction target to meet their global climate commitments and the United Nations 2030 Sustainable Development Goals (SDGs2030). The introduction analyzes what problems have emerged in China's Green Silk Road and Belt Economic Initiative (SRBI) and how global climate change is viewed to affect sustainable energy transition in the Central Asian countries. The paper will then focus on what response in national energy structureshave beenadoptedbyCentral Asian countries to addressglobal climate change commitments. The main focusof this paperis on how China's renewable energy investment in Central Asia contributes to solving essential problems for sustainable energy transition, bridging technical gaps and financial barriers for the low-carbon sustainable energy transition and aligning wth theParis agreement to fulfill global climate commitments. The limitedinstitutional capacity and market failure in renewable policy ecosystems in Central Asian countries jeopardizesdomestic climate investment and China's renewable investment potential,increasing national spending for sustainable development transition and triggering huge fiscal deficit and debt crises. This endogenous systemic risk deteriorates financial and technical barriers.This requires regional and multilateral renewables coordination and climate cooperation. China needs to set up a comprehensive green policy forthe Central Asian countries to get full support from local and international society. PPP and multilateral cooperation in the international renewables investment have not only mobilized more climate financial resources but also mitigate and diversify market failure risk.

Key words: China, Green Silk Road, Renewable, Climate Change, Central Asia, Innovation, Green finance

Introduction:

China's SRBI Projects have been known to spawn pollution problems with low environmental standards, such as water pollution from Chinese mining in Ghana. Massive environmental pollution in coal mining projects have caused local ecosystem devastation and high Greenhouse Gas (GHG) emissions problems. China has shifted away its overcapacity of heavy industry like the cement and construction industry, acarbon pollution-intensive industry whichgenerated high GHG emissions. Third, a major energy project of China's SRBI is for developing fossil fuel infrastructure, such as gas and oil pipelines from the Central Asia region to

China, as well as coal-fired power plants in Kazakhstan, Pakistan and Southeast Asia. According to anInstitute for Energy Economics and Financial analysis report in 2018, China has committed about $36 billion in financing for 102 gigawatts of coal-fired capacity in 23 countries, which represents more than a quarter of all coal-fired capacity under development outside of China (IEEFA). A growing international criticism of China's projects and their damaging effect on the local environment and high GHG emissions to atmosphere has spread across the globe. To some extent, the SRBI had become synonymous with environmental degradation and high air pollution. Therefore, it is significant to determine whether China's Green Silk Road Economic projects contribute to local sustainable development and to the NDC to Paris Agreement global climate commitments..

Initially, China's SRBI was designed with both environmentaland the Paris Agreement climate commitments concerns in mind. The 2015 "Vision and Actions on jointly building Silk Road Economic Belt and 21st Century Maritime Silk Road" Action Plan states that "efforts should be made to promote green and low-carbon infrastructure construction and operation management, taking into full account the impact of climate change on the construction." (VAoSRE). Under international criticism and skepticism in 2017 China published its documents "Guidance on Promoting Green Belt and Road," and the "Ecological and Environmental Cooperation Plan," Vision and Action of Energy Cooperation on jointly Building Silk Road Economic Belt and 21st Century Maritime Silk Road (VAoE). These documents emphasize that the SRBI investment projects will integrate regional energy markets and push forward the green and low-carbon energy development for implementing Paris Agreement commitments and the UN SDGs 2030. Green Belt and Road initiative called to carry out environmental impact assessments for the investment policy and strategy. Subsequently, in September 2017, China's seven industry associations and institutions, including the Green Finance Committee and the China Banking Association, jointly issued the "China Outbound Investment Environmental Risk Management Initiative"(GFC). This initiative aims to encourage and guide Chinese financial institutions and enterprises to strengthen environmental risk management in its outbound investment project, in compliance with the principles of responsible investment, and integrate ecological civilization and green development concepts into the "Belt and Road" economic initiative, enabling the SRBI investment to become "open, green, and clean".

China is a global leader in providing green technology and finance to solar, wind energy and hydropower, electric vehicles and batteries. According to Bloomberg Green data (Dan 2020), China is home to the most solar panels and wind turbines in the world, and is also the leading manufacturer of both solar panels and wind turbine. Thus, some international experts emphasized that China pursues its geopolitical advantage by using green investment tool, trapping Silk Road countries in China's green loans, causing huge debt problems. (Bernard, 2020, Lucas, 2019, Younis, 2020)

Global climate change has posed serious threats to the Central Asian countries' environment, ecological system and socio-economic development. Central Asian countries have significantly contributed to global

warming by generating large volumes of GHG emissions. According to the United Nation's report (2005) Kazakhstan is the 30th largest emitter of carbon dioxide worldwide and Uzbekistan has the most carbon intensive economy globally. (ESS, 2018). All the five Central Asian countries have already established an environmental legal and regulatory framework for meeting their NDC to global climate commitments under the United Nations Framework Convention on Climate Change (UNFCCC) (Renat Perelet, 2008). Their commitments focus oncarrying out a GHG emissions inventory periodically and mitigation studies.

Research questions: In light of this background the research question which arises is as the follows: How does this renewable energy investment of China's Green Silk Road Economic Initiative contribute to Central Asian countries' 2030 SDGs and their reducing GHG emissions blueprint to meet their NDCs to Paris Agreement global climate commitments? What natural potential do these countries have for developing renewable energy and why have they faced huge problems for the sustainable energy transition? What essential problems remain for China and Central Asian countries to jointly develop renewable energy investment? What optimal solution can be found to solving these problems in China's Green Silk Road Economic Initiative? Based on empirical data and counterfactual analysis this research made conclusions with several policy suggestions.

Literature review: There is a majorgap onthe integrationofChina's clean energy investment into the national sustainable energy transition target and national climatecommitments in the Central Asian countries in the international literature. There have only been a few attempts (Wilder, 2020, Nigora, 2020) to analyze the renewable energy solution for diversifying Central Asian energy systems to meet their Paris climate agreement commitments and the UN 2030 SDGs. There is a big gap concerning the positive and negative impacts of China's international renewable energy investment on the local sustainable energy transition and carbon dioxide emission reduction target in the published research articles. Some research hasalso created deep pessimism towards the role of China's Green Silk Road Economic Initiative in the sustainable energy transition in Central Asia.Central Asian experts Altynai and Kilner (2018)argued China's investment brought a huge debt risk and corruption to local society. Yau (2020) pointed out that China's state capitalism has nudged Kazakhstan and Uzbekistan to green their domestic energy production.Bradley Jardine (2019) observedthat China's investment lacks transparency and sometimes involved local corruption and triggered anti-China protests in Central Asia. However, some optimistic opinions have also prevailed. Catesby (2019) strongly pointed out that solar power could stop China's Belt and Road initiative from unleashing huge carbon emissions. This research arises out of debate with some scholars over how Central Asian countries respond to global climate change and the UN 2030 GSDs targets, does China's Green Silk Road Economic Initiative stimulate local sustainable development and contribute to local commitment to the Paris climate Agreement.

Key research findings: This research argues that China's rapidly growing clean energy investment made great contributions to Central Asia'ssustainable energy transition and CO_2 emission reduction targetsas part of aglobal climate commitment. Another important research finding is that most developing countries haven't established efficient carbon pricing mechanism and carbon offset market. Self-contradictory energy and climate financial policies and increasing national spending for sustainable development transition will trigger huge fiscal deficit and debt crises, creating market failures for renewables energy development and economic distortion, in equilibrium. This fiscal risk can be labelled endogenous risk rather than driven by the exogenous capital volatility and investment.Under this circumstance China need to set up a comprehensive "Green" policy to the Central Asian countries to get full support from local and international society, China also need to balance innovation, competition and local inclusive development in its international renewable energy investment, promoting PPP ad multilateral cooperation tobridge thebig gap between Chinese international renewable energy investment and its impact on the local sustainable development.

Data Collection: The empirical data for this research was carried out between January 2018 and October. 2020. The authorhas also accessed the dataset of China's National Development and Reform Commission, Central Asian countries' energy database, the United Union report (2015), the International Renewable energy Agency dataset (2019), World bank and Asian Development Bank dataset regarding climate change and clean energy investment, as well as the World Bank's emission estimation metric report (2020).

1. Sustainable Energy problems in Central Asia and renewable energy solution

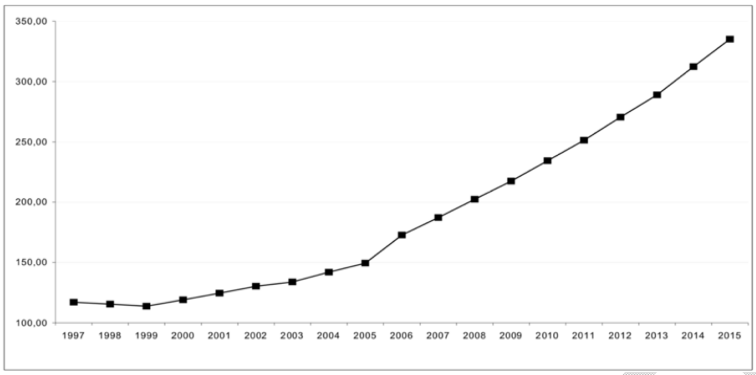
Most developing countries and emerging markets have suffered from an insufficient energy supply problem and a fossil fuel-centered high GHG emission environmental risk. Moreover, the energy efficiency is rather low in all Central Asian countries since, in particular, they retain the energy and carbon intensive economy model. Therefore, their energy supply and consumption need to shift to a sustainable energy model. Central Asian countries have the most complex and fragmented energy supply paradigm consisting of energy-rich and energy-poor counties, Kazakhstan, Uzbekistan and Turkmenistan heavily reply on fossil fuel, Tajikistan and Kyrgyzstan overwhelmingly rely on hydropower in summer and spring.

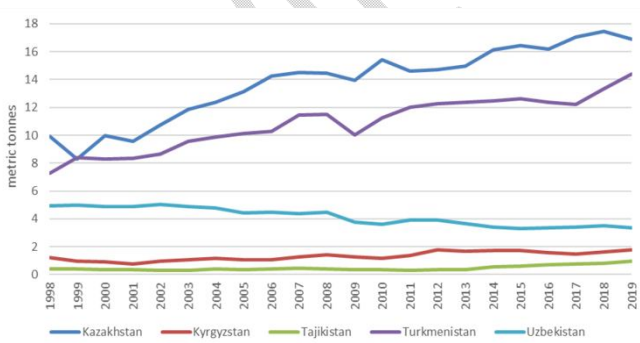
1.1 Fossilfuel-centered energy structure and low energy efficiency in Central Asia

This research analyzes a sustainable energy systembased on energy efficiency and national energy structure paradigm. As the Table-1 indicates, the fossil fuel energy dominated in Central Asian energy consumption and trigger high GHG emission environmental problems. There are three energy exporting countries: Kazakhstan, Turkmenistan and Uzbekistan. In Kazakhstan and Uzbekistan fossil fuel consumption exceeded more than 98% of total energy consumption between 1992-2014. Kyrgyzstan fossil fuel energy consumption shares exceeded70% during 1992-2014.Their energy intensity level is attributed to the middle-high energy intensity model of the Middle East countries. The share of fossil fuel consumption largely exceeded

the Paris Agreement required energy scenarios and the International renewable energy agency metrics(Note-1). Their overwhelmingly dependence on fossil fuel energy triggers high GHG emission pollution and threating global climate change. Kazakhstan average carbon emission exceeds the average carbon emission level of middle income countries (CO2 Dataset). Its energy sector generates about 80% of its total GHG emission. Therefore, Central Asian countries need to diversify fuel-based energy systems to the sustainable energy consumption and production.

Graphic-1: **CO_2 emission in Kazakhstan's energy sector, in mil t. Graphic-2: CO_2 emission per capital in Central Asian countries**





As the Graphic-1 (Source) and Graphic-2 (World Bank 2019, Nguyen A. T. 2019, Friedlingstein 2020) shows that the growth in carbon emission in Central Asian countries faster several times than in 1990s. Therefore, Kazakhstan, Turkmenistan and Uzbekistan have faced the challenge from their high GHG emission fuel-based energy system to fighting climate change problem. In 2020 all the Central Asian countries have started to fulfill their Paris Agreement commitments to reduce carbon emission in transportation, industry and energy consumption, increasing renewable energy share in their energy mix and investment portfolios(Task),in order to mitigate global climate change threat to their social-economic development.From other hand, to fulfill the UN SDGs 2030, transitioning the fuel-centered energy system and improving energy efficiency is main roadmap to reduce GHG emissions and mitigate climate change risk. Thus, improving energy efficiency and renewable energy share, reducing GHG emission in general have already constituted to an important part of the climate policies in Kazakhstan, Turkmenistan and Uzbekistan.

Table 1: Energy: Economy Metrics (ADB-Database)

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Fossil Fuel Energy consumption avg. 1992-2014, % of total	98.21	70.02	41.36	N/A	98.52
Energy use, KG of Oil equiv. per capital, avg. 1992-2014	3,585.68	590.79	369.26	3,753.86	1,881.34
Energy intensity level of primary energy, MJ/$2011 PPP GDP, avg. 1992-2015	10.54	10.49	9.57	22.58	26.56

GDP per unit of energy use, PPP $ per kg of oil equiv., avg, 1992-2014	3.56	3.67	4.40	1.67	1.54
Adjusted savings: energy depletion avg. 1993-2016, % of GNI	8.96	0.15	0.04	22.76	10.64
Energy imports, net, avg. 1992-2014 % of energy use	-93.56	52.13	37.75	-189.05	-13.49
GNI=Gross National Income					
Non-Fossil Fuels					
Alternative energy avg 1992-2014, % of total energy use	0.94	20.53	49.13	0.00	1.19
Renewable energy consumption, avg. 1992-2015, % of TFEC	1.71	26.74	57.10	0.06	1.84

In Central Asia the aging infrastructure wasconstructed in the Soviet Union, whichnot only limits energy supply and export capacity, but also have increasingly become inefficient and unreliable energyfacilities. The energy supply security is a serious problem due to poor unreliable energy infrastructure. Therefore, the potential energy and power supply capacity mismatch its market consumption in Central Asia. Moreover, the low energy efficiency and energy intensive economic model enables the energy consumption to be very high(Sust, 2018)

Table-1 shows that all countries in Central Asia have low energy efficiency and high energy intensive economic models. This enables adjusted saving rates in Central Asian countries have been moderate with high environmental problems and high resources depletion and low investment rate. This has constructed a big gap between available financial resources and the required financialcapacity for sustainable energy transition to achievethe UN SDGs2030.Kazakhstan, Uzbekistan and Turkmenistan have high fossil fuel energy depletion vs low adjusted savings rate, whichsuggests that these countries have high natural capital degradation and huge stranded fossil fuel capital for de-carbonization transition, this decreases fiscal revenue, triggering public financial volatility and a possible fiscal cliff. Thus, improving energy efficiency and diversifying fuel-centered energy supply is crucial to manage sustainable energy transition and environmental problem in Central Asia.

1.2 Promoting Renewable energy and mitigating climate change risk in Central Asia

The carbon intensive economic model and highGHG pollution energy system in the Central Asia countries is formed by the increasing consumption of fossil fuels. Central Asia needs to double its electricity output by 2030 for their GDP growth and market demand. This expected economic growth will require new energy sources of power generation. All the central Asian countries have already ratified the Paris Agreement on climate change and committed to dramatically reducing fossil fuel for power generation, making their transmission system more efficient, adopt renewable energy to reduce carbon emissions and satisfy their growing electricity demand. Central Asian countries set strong commitments to tap renewable energy sources and clean technologies.In 2019 All the energy ministers of Central Asian countries committed to collaborate in

order to meet the 2030 UNSDG 7 which pledges"affordable, reliable, sustainable and modern energy for all" to be achieved by 2030. (CAC, 2019,UN SDG 7)

The International Renewable Energy Agency Report (IRENA)(GET, 2019) highlights that increased use of renewable energy, combining with intensified electrification, could prove to be decisive solution for the world to meet climate goals by 2050. Based on IRENA's analysis, energy-related carbon (CO_2) emission reductions would have to decline 70% by 2050 to meet the Paris Agreement global climate commitments. A large-scale shift to renewable power could deliver 60% of GHG emission reductions, and 75% of GHG emission reductions if renewables for heating and transport are factored in, and 90% with ramped-up energy efficiency. This aims to create reliable, sustainable energy system in line with the UN SDGs 2030. (GET, 2019). However, the renewables' share in the power generation is very low in Central Asian countries. (Komila, 2018) Renewables contribute just 3 percent of power-generation in Kazakhstan, the vast majority of power generation is still made by coal in Central Asia. (Niva Yau, 2020)· Given the current low installation of renewables and high GHG emission, rapid increase in renewable investment is urgent needed in Central Asia. Renewable solution will meet climate regulatory benchmark and sustainable energy transition in Central Asia, driving to mitigating GHG emission and improve energy supply security for GDP growth and market consumption.

2. Developing Renewable energy policy and its ecosystem efficiency

Most countries along China's Silk Road and Belt Economic Initiative have huge natural potential for developing hydropower, wind and solar energy. According to the SRBI countries' targets for renewable energy (NDRC-Data), the projected installation capacity of renewables for 38 countries in SRBI could reach 644 GW from 2020 to 2030. Central Asia possesses vast renewable energy resources like solar, wind and water, this provides natural advantages to develop renewables. Kazakhstan aims to reach 50% of total electricity from renewables by 2050. (DRECA, 2020). Turkmenistan has developed gas power plants, Kyrgyzstan and Tajikistan mainly develop small hydropower, and have huge potential resources for developing the large hydropower. ydropower potentially accounts for 98% of the electricity produced in Kyrgyzstan and Tajikistan. Though Uzbekistan has huge potential resources of renewable energy, solar and geothermal dominated renewables sources, they haven't been applied yet. However, coal power plant share is 19.3%, gas power share is 66.4%, hydropower share is only 13,3% of total power generation in Uzbekistan. (ESU,2021).

2.1 Renewable energy law and climate incentive policy in Central Asia

Except Turkmenistan, all the Central Asian Countries have set up a renewable energy development target. In 2013, Kazakhstan adopted the "National Concept for Transition to a Green Economy up to 2050" (Andres Fernandez, 2018)outlining a future development pathway guided by renewable energy policy. The ambitious plan aims to increase the share of renewable energy in power generation to 30 percent by 2030 and 50 percent by 2050 to fulfill its commitment on the Paris climate Agreement. In 2013 Kazakhstan passed a new renewable

energy law, this ensures a renewable energy development strategy to attract national and international investment, introducing regional feed-in tariff mechanism (Note-2) and designing the power purchasing agreement (PPA). Kazakhstan and Kyrgyzstan have already implemented feed-in tariffs policy for renewables, while Kyrgyzstan and Tajikistan have tradable renewable electricity certificates (IEA R-2020, UNDP R-2021). Turkmenistan has so far not established a renewablepolicy. In 2019, Uzbekistan planned that renewable will share 20% of power generation in 2025 and will reach 25% in 2030. In Uzbekistan the Renewable Energy Law entered into force on May 22, 2019. Uzbekistan has approved the Renewable Energy Law to grant tax privileges to renewable equipment manufacturers, and 5 years free tax for all the registered renewable energy companies.(DREU, 2020)

The Central Asian countries renewable energy laws established a regulatory framework for developing renewables, whilefeed-in tariffs policy has attracted domestic and international investment in renewable projects. In particular, it has stimulated Chinese investors to startup renewables projects. Along with other incentives policy like renewable subsidies, tradable renewable electricity certificates and customs assistance for importing and applying renewable technologies, building renewables projects are associated with a state guarantee to connect the renewables to the unified national electrical network. Automatically including renewables in national grid and national electricity demand plans enable new investors and entrepreneurs avoid market uncertainty risk and price volatility caused by market failure and distortion in renewables, also providing flexibility for establishing own local trade network. The renewable energy law and incentive policies have set up a prudential precondition for stimulating international renewables investment in Central Asia.

2.2 Market failure and Uncertainty for developing renewables energy in Central Asia.

However, the Central Asian countries' renewable law also contains anunclear pricing mechanism for determining renewables market price and tariffs. This uncertainty limits the investors' willingness to make long term plans for renewables investment. In addition, the high subsidies for fossil fuels and electricity in Central Asia make very low electricity price, have impacted the renewables price and have also distorted the renewables investment market, causing renewable energy to be less competitive and become an unprofitable investment in all the Central Asian countrie. Rrenewablesources havebecome less attractive for the long-term profit-oriented competitive private capital. This has triggered the inefficient allocation of financial resources and market failure of attracting long term financial resources. This inefficient incentive policy ecosystem was created by the market failure and government policy failure, as well as the artificial and asymmetric market power. The market power has failed to correct the fossil fuel centered energy structure, and this market failure has been exacerbated renewables disequilibrium among demanding market and investmentpotential,whichjeopardizes China renewables investment in Central Asian countries.This market failure may be remedied to some extent at the

political level by establishing of an international or regional coordination mechanism to internalize the international climate and renewables investment for developing local climate mitigation measures.

In addition, there also some uncertainties associated with regulatory and policy limitations in Central Asian countries, such asconflicts within legal and institutional framework for supporting renewables development, lack of or weak institutional capacity for implementing climate mitigation and adaptation policy, all of which have undermined the renewables investment and enable promoting renewable investment policy less efficient, hampering large upfront costs for climate investment, in particular for private capital flow to renewables investment. Market failure, limited institutional capacity and government policy failure caused inefficient market outcome and inefficient government interventions in renewables investment. Thus, Central Asian countries haven't yet established an effective developing renewable ecosystem.

3. Technological barriers for developing renewable energy in Central Asia

3.1 Technological barriers for developing renewables in Central Asia

Huge renewable energy resources remain underdeveloped and untapped in Central Asia due to various tech barriers and lack of financial resources. Tajikistan is plagued with regular energy shortages, but because huge technological barriers and financial difficulties amperthe hydropower potential in Tajikistan, about 300 billion kilowatt-hours, remains mostly untapped. Once completed the dam would be one of the tallest in the world at 335 meters and would be 1,500 meters wide. It is estimated that it would take seven to twelve years for the Vakhesh River to fill the reservoir. The project would force the resettlement of over 30,000 people.(Philip H.De Leon, 2020). Another barrier is the lack of know-how and a limited number of local technology providers and specialists in the renewable (Komila. N 2018). Thus, technological barriers are the principle deterrents for developing clean energy in Central Asia.

3.2 China's leading position in renewables technology and its installation capacity

As the International Renewable Energy Agency statistics (Statista-Data, 2020) show, China provides 29% of the international renewable patents. China has by far the most renewable energy patents with the U.S., Japan and Europe lagging behind. According to the International Renewable Energy Agency data "No country has put itself in a better position to become the world's renewable energy superpower than China. (Charlie Campbell, 2019) The leading position in renewable technologies will help China to format its 14thFive Year (2021-2025) social-economic development plan targeting more international high technologies' with Chinese standards, expanding China's green high technologies to the international market. This has opened the great potential and huge opportunities for the enormous expansion of exporting wind turbine and solar panel and technological solution for renewable energy installation globally. Thus, Green Silk and Belt Economic Initiative will set up great market value chain for China's 13thFive Year (2016-2020) social-economic development proposal "2025 made in China" Industry target to exporting its green products and green technologies.

China has been the world's leading renewable energy investor for years. It has the world's largest installation capacity and the biggest clean energy economy with 3.5 million green jobs. China is the world leader in wind energy, with over one third of the world's capacity. Its wind turbine represents the most effective and immediate solution for reducing GHG emission. The global energy transformation to 2050 shows that renewable energy is technically and economically feasible to ensure a climate-safe sustainable energy future, and China would take the lead with 2525 GW (IRER-2019)of installed onshore and offshore wind capacity by 2050.

3.3China lacks renewables technology transfer mechanism and has limited market access capacity

China's solar, wind and battery technologies are now increasingly present in overseas markets, its electric vehicles and the intelligent energy-management systems are set to follow. China dominated in global supply chain of renewables and become the number one exporter of environmental goods and services, overtaking Germany and the US renewable energy investment along the Silk Road Belt Countries, supporting environmental friendly sustainable development throughout the SRBI countries.

However, China's clean energy technologies are mostly associated with China-led clean energy investment projects, also integrated with its Outbound Direct Investment and exporting green equipment, goods and services together to the SRBI countries, aim to serve its domestic manufactures capacity and market expansion strategy. Chinese renewable incentive policies like renewable subsidies, feed-in tariffs export credit policy encourage its clean technology goingglobal. But China has not built an independent clean energy technologies transfer platform and market strategy, China is lack of market formation and R&D cooperation with recipient countries. Central Asian countries also haven't forged a clean energy technologies market mechanism. China's 14th social-economic development Five Year plan aims to promote China's clean technology for commercialization and international mobility, whichwill promote China becoming a main player in the international clean technology transfer and dissemination during the 14thFive Year plan period (2020-2025).

Other clean energy leading countries and international organizations have started to deliberately create a clean energy technologies market in Central Asia. The UN Environment program collaborates with the Korea International Cooperation Agency to facilitate clean energy technologies dissemination and the market development in the Central Asian countries through facilitating policies and regulations, developing national clean technology action plans, and establishing energy performance standards. (UNEP). This clean energy transfer platform will disseminate the renewable technologies across the Central Asian countries, competing and co-existing with Chinese clean energy technologies. Thus, China would not absolutely dominate Central Asian clean energy technologies market and has limited market access capacity. However, China's clean energy technologies mostly will serve China's clean energy investment project, whichprovides an alternative technological solution for local renewable energy investments, contributing to the local renewable technology innovation capacity building, it also will dramatically reduce cost of renewables investment in Central Asia.

4. Financial barriers for developing renewable energy and China's green capital in Central Asia

4.1 Big gap between demand and available climate finance in Central Asia

Central Asian countries energy capacity expansion will require about $400 billion in cumulative investments to 2030.(CACE-2019). All the Central Asian countries haven't established carbon market and carbon pricing mechanisms. Essentially, carbon pricing is the cost-effective way to mobilizing financial resources and raising fiscal revenue, incentivizing clean energy development and green tech R&D. Carbon offset market and carbon pricing is an important instrument for mobilizing climate finance and play an important role in catalyzing low-carbon investment. Thus, the Central Asian countries haven't established the cost-effective climate policy to allocate financial sources for renewable investment. The feed-in tariff for renewables and high subsidy to fossil fuels have already triggered heavy fiscal burdens for Central Asian countries. Thus, the regressive energy subsidies system is inconsistent with the pricing signal for the GHG emission environmental externalities, while fuel subsidies and carbon pricing both aggravate the fiscal deficit in Central Asian countries. Potential huge stranded fossil fuel assets also generate high public financial risk and fiscal cliff crisis. Obviously, Central Asian countries have faced the growing fiscal pressure and have struggled to obtain financial resources for developing renewable energy.

In Central Asia local investors in renewable energy have very limited access to affordable bank loans and often cannot afford high initial investment costs. (Komila, N 2018). These countries also haven't established efficient climate fiscal intervention tools and climate financial policy to mobilize public and private capital to renewables investment, in addition, they have low adjusting saving rate **(**Table-1). Essentially, renewable development requires access to long term funding on a project finance basis, andlong-term projects financing demand widely exceeds current and planned investment in Central Asia. Thus, due to lack of long-term financial resources the existing investments in clean energy cannot satisfy the demand of sustainable power generation and sustainable energy transformation in the Central Asian countries.

Obviously, the current renewable investment in Central Asia is still insufficient to keep diversifying its fossil fuel-based energy system and reducing carbon emissions to achieve its international commitments to the Paris Agreement. According to the global renewables finance report, global investment in diversifying renewables technologies must almost triple annually to $800 billion by 2050 to achieve its climate commitment (GREF-2020). Central Asian countries have received comparatively low levels of financial resources for renewables, with average annual investment of $ 5-6 billion each during 2013-2018. However, according to the World Bank assessment dataset in Central Asian countries power discounted system costs is $155 billion between 2019-2030 (CAET-2020). Apparently, the Central Asian countries urgently need the foreign investment to bridge its domestic renewables investment finance gaps.

4.2 China's Green climate finance and its multilateralism in Central Asia

China has injected huge climate capital into the international renewables investment. According to the 2019 Renewables Global Status Report (REN21) China led renewable energy investment worldwide for the seventh successive year, contributing to almost a third of the global renewables investment in 2018 at $130.2 billion. This is nearly triple than the investment by the U.S and more than double size of the EU renewable investment.

China's Green Silk Road Economic Initiative has promoted incentives for green and clean investment committing to helping the local countries to implement their national commitments to the Paris Agreement. In 2017 China launched the "One Belt One Road Green Climate Bonds " initiative funds that aims to develop and promote clean energy investment, energy efficiency, cleaner transportation, pollution control, conservation, recycling, and ecological protection in the SRBI countries. China also adjusted public financial policy for mobilizing more private capital flow to climate-friendly investments. Under the direction and support of China's Green Silk Road and Belt Initiative and its SRBI Climate Bonds China has become a leading country in renewable installation capacity and renewables investment. Thus, Now China is the world's largest investor, producer, exporter and installer of solar panels, wind turbines, hydropower.

China leads the world in its installed total renewable power capacity, particularly in hydropower, solar PV and wind power. (UNRE-2019) China's direct investment in the SRBI countries has supported 12.6 GW wind and solar power generation capacity in July 2019, and it was 450MW before 2014 (Mark Hutchins 2019). Estimates from Wood Mackenzie global solar PV market outlook (2019) predicts that China's photovoltaic panel installations hit a cumulative total of 370 GWdc by 2024 - more than double the United States' capacity at that point.(GSPV-2019).

China's bold vision is to create a global renewable energy grid that connects renewable energy across hemispheres. The wind and hydropower of Central Asia are a vital component of this grid. Chinese government and the SRBI investors will develop the blueprint for a United Renewable Energy System of Central Asia. (Alejandro L.,2019) This infrastructure connectivity will stimulate more renewable investment and renewable power plants, this is the important part for China's Green investment and green product exporting market.

China implements multilateral partnerships in its international renewable energy investment. Kazakhstan's Zhanatas wind power plant, the largest of wind power plant at a 100-megawatt in Central Asia, has gotten loans of $ 46.7 million from the China-led AIIB, is operated by China Power International Holding Limited, a subsidiary of State Power Investment Corporation. (AIIB, 2019). The European Bank for Reconstruction and Development (EBRD) and the AIIB co-financed with the Industrial and Commercial Bank of China (ICBC) a concessional loan from the Green Climate Fund (GCF). China Power International Holding (CPIH) partners with Visor Investments Corporate in the construction and operation of the 100 MW wind power plant Zhanatas. This is one of the largest windfarms in Central Asian region. (KAR,2020). China has helped Kazakhstan to

boost its renewable energy investment including the construction of Kazakhstan solarfarms in 2018: Burnoye Solar-1, Burnoye Solar-2, Nurgisa 100MW solar park and other solar plants in Mangystauwas sponsored by EneverseKunkuat, a Kazakh-Chinese joint venture.(Nazrin Gadimova. 2019).

Table 2. Multilateral partnerships in its international renewable energy investment

Kazakhstan	Uzbekistan	Kyrgyzstan	Tajikistan
Hydropower	Turgusun-1;2; 3.[N-3] Moynak hydropower plant [N-4]	expanding the capacity of hydropower stations in Tashkent and Andijan [N-5]	Joint modernization of Toktogul, hydropower stations [N-8]	Joint modernization of Nurek hydropower stations [N-9]
	Renovation project of three hydropower stations in Tashkent Two hydropower stations [N-6]	In the Fergana Valley		
		Hydropower station at the Tuyabugiz reservoir [N-7]		
Wind	Zanatas 100MW wind farm [N-10] [N-11]			
Solar	Alatau Innovation Park [N-12]			
Karaganda Solar [N-13]				
Zhangiztobe Solar [N-14]				
Kapshagay Solar [N-15]				
Burnove Solar 1-2				
Mangystau Solar				
N=Note				

The aforementioned solar and wind power plants' investment was undertaken by Chinese and Kazakhstan's investors, as well as the multinational development banks like EBRD and AIIB. Apparently, China's investment in renewables partners with the local investors and international investors. Themultilateral shareholders structure serves as an institutional commitment vehicle to renewable projects; this multinational framework will not only increase financial institutional capacity, but also mitigate uncertainties and diversify market risk.

China's overseas renewables financial investment has been channeled by multiple sources including banks' loans, government funds, private equity and venture capital, sometimes also cooperating with local and multilateral banks and multinational funds. Under the circumstances of multilateral investment sources and multinational shareholders of renewables projects in the Central Asian countries, the renewables projects will be

determined by multilateral shareholders, requiring more transparent decision-making processes, reducing single dominant investor risk, in particular avoiding any single investor financial shock or debt risk.

4.3China's state-own capital and PPPin international renewable investment finance

China's National Development and Reform Commission dataset shows that Chinese state-owned banks and commercial banks include China Export and Credit insurance cooperation, development bank and import-export bank strive to provide concession financial loans for its international clean energy investment. The following charts (1-2) show that China's state-own banks have shared a little portion in its international renewable energy investment capital. China public finance and China carbon offset institutions yield strong finance incentive leveraging private capital, venture capital and private equity, crowd fund as well as other financial channels to build a clean-tech Fund. Among others, private-public partnerships(PPP) increasingly play an important role in China's international renewables investments. The dramatically growing private capital market in China become an important channel for solving climate finance constraints.China has established a wide range of finance incentive policies in catalyzing massive private capital investment in renewables.Thus, some skepticism existsthat China's huge investment will trapthe SRBI countries in potential debt risks. Yet China's state-own capital shares little of its international renewables investment as the following charts show that in 2017 China's overseas clean energy investment reached to $132.6 billions, but the state-own banks loan share around $1 billion renewable investment, State own-bank finance accounted just for a total of around $4.5 billion from 2013-2018.

China's huge venture capital sources have successfully transferred China into a technologically innovative leader, and putChina on the map in the venture capital and financing innovation, in particular in clean energy and digital infrastructure investment. The aforementioned Kazakhstan's wind farmer project -Zhanatas wind power plantindicates that private equity, venture capital, international green funds, multinational development banks, other international investors as well as the local investors pooled capital with China private capital and state own loans together in renewable investment. China's state-own capital has gradually shrunken in its SRBI clean energy investment. In addition, China renewable energy project supported by the International Bank for Reconstruction and Development loans and the global environment grant to encourage manufacturing of small scale solar system, China's Silk Fund also support both energy efficiency and renewable energy projects with emphasis on transfer of skills and learning, and the export credits are also being used creatively by China's commercial bank to mobilize private capital flows to the renewables investment in the SRBI countries.This promotes cyclic PPP incentive mechanismsto develop international renewables investment ecosystem.

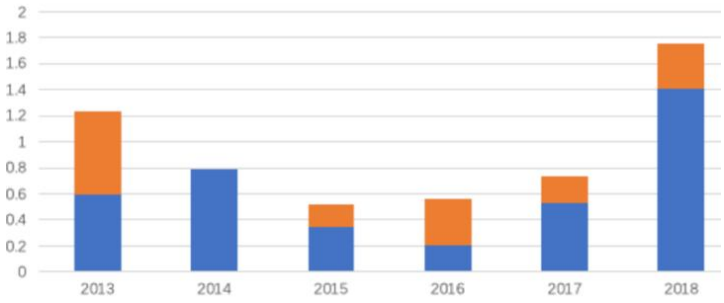


Chart-1Chinese Project Loans for Renewables 2013-2018, Investment (In Billions USD) (NRDC dataset)

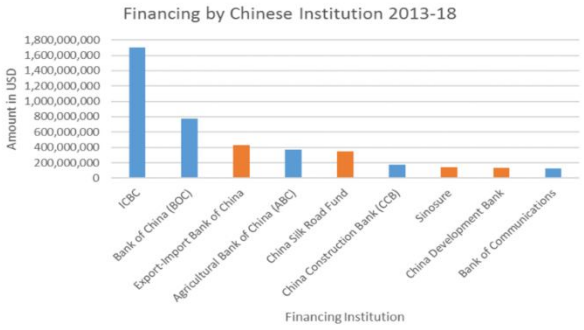


Chart-2(NRDC dataset) Blue color: China Commercial Banks, Orange Color: China State Policy Banks

China has built the world largest carbon offset market and can dedicate a fraction of its carbon linked fiscal revenue to its international climate finance to support renewables investment in the SRBI countries. In 2020 Chinese national carbon trade schemes started to mobilize climate finance.Green finance reform development will dramatically increase China climate finance capacity building and diversify climate finance resources to leverage private finance; state-own capital will also increase its international renewables investment in the SRBI countries. It would also strengthen a domestic supply channel for public-private partnership (PPP) climate finance in its outbound renewable investment. In addition, the reform of fossil fuel subsidy in China would drive energy transition to renewables, improve economic efficiency and free up scarce public financial resources to be devoted to climate finance. Therefore, it is reasonable to infer that China state-own capital as the public climate finance certainly have great potential to be dramatically increased since 2020 after carbon trade scheme and carbon offset market have gradually gotten full functional in China.

Conclusions and Policy Recommendations

Before issuing the Green Silk Road Belt Economic Initiative in 2017 China's oversea renewable investment was far less than its financing scale of fossil energy such as oil, natural gas and coal investment. It was also far below the World Bank average energy mix loan share rate (Note-16). After issuing Green Silk Road and Belt Economic Initiative in 2017 China has emphasized increasing financial support for overseas renewables, since then China has gradually devoted its financial resources to renewables and low-carbon and energy efficient infrastructure investment.

International clean energy cooperation is a significant platform for promoting the UN 2030 SDGs and the Paris Agreement reducing GHG emissions. Due to lack of the effective leading and organizing international research cooperation for clean energy development and utilization de-carbonization technology, Central Asia countries haven't yet established clean energy technology transfer platform and market. The market failure has

not only undermined national and regional renewables development ecosystem, but has also jeopardizeChina's outbound renewables investment and the further international renewables cooperation.

China needs to combine its incentive policies for its renewables' exporting with its innovation incubation policy for the international economic corridors in the SRBI countries, China also needs to continue stimulating a multilateral and regional cooperation framework in financial and technological support toward the renewables' technologies and finance capacity building in the Silk Road and Belt countries, craft a comprehensive policy for its international renewable investment.

Limited financial resources have always impeded the renewables investment. To diversify and increase the green financial sources for renewables, the following approaches are demonstrated effective: promoting the public-private partnerships (PPP), attracting private capital, constructing the international green investment (bonds) funding for clean energy project through modern capital-assets (crowd equity) financial system. Other tools include using digital financial platform to build sustainable energy development financial pool, optimizing the digital inclusive finance to support micro small and medium size enterprises (MSME) participatinginrenewable energy investment, joining the World Bank alleviating poverty and inclusive development program, attracting Micro-Small-Medium finance to invest in renewable projects. Beside theaforementioned approaches, implementing the cost-effective climate mitigation policy like carbon pricing, building carbon offset market and fossil fuel subsidies reform also can release more fiscal space and allocate domestic financial resources to renewables investment, whicalso can reduce fiscal deficit risk and debt pressure.

An effective multilateral framework of international renewables investment is important for international investors and climate investment recipient countries. An effective coordination mechanism is necessary for climate funding among the China-led Asian Infrastructure Investment Bank and New development Bank, as well as other multilateral banks like Asian Development Bank, European Bank for Re-construction and Development and the World Bank to consolidate the international efforts for developing renewable projects. These effective multilateral mechanisms not only can mitigate geopolitical tensions and confrontation, but also can stimulate cutting-age technology transfer and create a new market value chain.

Abbreviations

ADB Asian development Bank

AIIB Asian Infrastructure Investment Bank

EBRD European Bank for Reconstruction and Development

GDP Gross Domestic Product

GHG Green House Gas

NDC National Determined Commitments

UN United Nations

UNFCCCUnited Nations Framework Convention on Climate Change

MSME Micro small and medium size enterprises

SDGs Sustainable Development Goals

SRBISilk Road and Belt Economic Initiative

PPP Public Private Partnership

R & D Research and Development

Dataset:

ADB-Database: Asian Development Bank research paper and Word Bank Database. https://www.adb.org/sites/default/files/publication/522901/adbi- wp993.pdf

WB-Database:

https://databank.worldbank.org/source/world-development-indicators. Accessed 24 Feb. 2020.

World Bank (2019). World Development Indicators. Per Capita CO2 Emissions in Central Asia.https://databank.worldbank.org/data/reports.aspx?source=2&series=NY.GDP.PCAP.CD&cou ntry=#.

Statista-Data: Share of renewable patents globally by country | Statistahttps://www.statista.com/statistics/957485/cumulative-share-renewable-patents- worldwide/. Accessed at this website 10 December, 2020.

CO2 emissions (kt) | Data (worldbank.org): CO2 Emission database for global atmospheric.

Accessed at this website 10 October, 2020.

NDRC-Database: The Natural Resources Defense Council (NRDC) dataset, Green Power Projects for the Belt & Road Initiative (BRI), April 2019. https://www.nrdc.org/experts/han-chen/greener-power- projects-belt-road-initiative-bri, accessed 10 September, 2020. In English language.

Special Notes:

`Note-1. According the International Renewable Energy Agency report, 84% of energy use comes from fossil fuels, with 16% derived from renewables (IRENA, 2017). Analysis by the International Renewable Energy Agency (IRENA) shows how through accelerated uptake, 65% of energy use could come from renewables by 2050. This would be enough for countries to meet the Paris Agreement climate commitment. Renewable energy currently represents about 25% of global electricity generation, with the rest generated by fossil fuels, according to IRENA's global energy roadmap, known"Remap". Around 80% of all electricity in 2050 could be

generated by renewable energy (IRENA, 2017c). This can be found at website of the international renewable energy agency: A9561C1518629886361D12EFA11A051E004C5C98 https://www.irena.org//media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_A_key_climate_solution_2017.pdf?la=en&hash= A9561C1518629886361D12EFA11A051E004C5C98 Accessed at this website 10 December, 2018.

Note-2. It recommended the adoption of a uniform feed-in tariff structure, providing identical tariff levels for renewable energy projects based on technology, in order to increase transparency, investment certainty and ease of project approval. Feed-in tariff as advance market commitments to subsidize renewable energy projects but less efficient than carbon pricing offset market such as carbon trade scheme and carbon tax, and it can trigger relevant fiscal implications and increases fiscal financial burden.

Note-3. China International Water & Electric Corporation. Turgusun Hydropower Project in Kazakhstan realizes the second-phase diversion." 22 October 2019, http://www.cwe.cn/contents/projecttrends/9216.html. Accessed March 12, 2021.

Note-4. Moynak hydropower plant. State-owned China International Water & Electric Corporation and China Hydropower Foreign Corporation undertook the construction of the largest hydropower station in Kazakhstan since the founding of the country." April 10, 2008, http://www.gov.cn/ztzl/2008-04/10/content_941526.htm. Dec. 20. 2020 accessed.

Note-5. China National Electric Engineering Company. Uzbek Hydropower Project User Return Visit and Safety Inspection Successfully Completed. August 4, 2010, http://www.cneec.com.cn/xwzx/gsyw/201008/t20100804_78060.html. Accessed June 10, 2020.

Note-6. Modernizing five dams, including three in Tashkent and the Fergana Valley. The renovation project of three hydropower stations in Uzbekistan under the preferential purchase loan of the Chinese government started implementation. July 9, 2018, http://uz.mofcom.gov.cn/article/jmxw/201807/20180702764213.shtml. Accessed Feb. 20, 2020. The Export-Import Bank of China. "China Eximbank Signed Hydropower Project Loan Agreement with Uzbekistan's Turonbank." Mayhttp://english.eximbank.gov.cn/News/NewsR/201810/t20181016_6948.html. Accessed Dec.10. 2020

Note-7. Dongfang Electric Corporation completed construction in 2019 of an entirely new $15.8 million, 11.4 MW hydropower station at the Tuyabugiz reservoir south of Tashkent with $8.1 million in Construction of Tuyabguz Hydropower Station in Uzbekistan completed, contracted by Dongfang Electric." April 8, 2019, http://www.sasac.gov.cn/n2588025/n2588124/c10916783/content.html. Nov. 10 2020 accessed. Kun. "Tuyabugiz Hydroelectric Power Station commissioned." March 27, 2019, https://kun.uz/en/49250257?q=%2Fen%2F49250257. March 18. 2021 accessed.

Note-8. Asian Development Bank. Kyrgyz Republic: Toktogul Rehabilitation Phase 3 Project. 2016, https://www.adb.org/projects/49013- 002/main. Dec. 12. 2019 accessed.

Note-9. World Bank. "World Bank Supports Rehabilitation of the Nurek Hydro Power Plant in Tajikistan." https://www.worldbank.org/en/news/press-release/2019/03/20/tajikistan-nurek-hydropower-rehabilitation-project. Sep. 11. 2020 accessed.

Note-10. Chinese-built Zanatas 100MW wind power farm began to generate electricity. (2019-2020) largest wind farm. 80% owed by by Power China, joint fund from the EBRD, AIIB and Industrial and Commercial Bank of China etc. Central Asia's largest wind power project officially received loan support from institutions such as the Asian Infrastructure Investment Bank. October 29, 2020, http://kz.mofcom.gov.cn/article/jmxw/202010/20201003011665.shtml. Accessed July 18, 2020.

Note-11. According to the International Renewable Energy Agency. Energy Profile: Kazakhstan (2019). https://www.irena.org/IRENADocuments/Statistical_Profiles/Asia/Kazakhstan_Asia_RE_SP.pdf. Accessed Aug. 18, 2020. As of 2019, Kazakhstan has a total wind capacity of 284 MW, at least 161.5 MW of which are generated through joint projects of Chinese and Kazakh companies.

Note-12. 2018 grant, IMW solar plant to the Alatau Innovation Park near Almaty

China-assisted construction of solar and wind power plants in Kazakhstan put into use. Dec. 1. 2018, http://www.xinhuanet.com/fortune/2018-12/01/c_1123793953.htm. Accessed March 5, 2021

Note-13. Ningbo-based Risen Energy started working on a $39 million, 40 MW solar photovoltaic plant in Karaganda. Risen Energy further advances the construction of the Belt and Road Initiative, and Kazakhstan breaks ground for a 40MW photovoltaic power station. June 11, 2018, https://www.risenenergy.com/index.php?c=show&id=156. Aug. 22, 2021 accessed.

Note-14. Universal Energy's Zhangiz 30MWp photovoltaic power station is the first photovoltaic power generation project in East Kazakhstan. 16 August 2019, http://www.universalenergy.com/zh/news/243. Nov. 16, 2020 accessed. European Bank of Reconstruction and Development. KAZREF – Universal Energy Zhangiz Solar. 2019, https://www.ebrd.com/work-withus/projects/psd/kazref-universal-energy-zhangiz-solar.html. Dec.10 2020. Accessed.

Note-15. Universal Energy's Kapshagay 100MWp photovoltaic power station is connected to the grid for operation. September 3. 2019, http://www.universalenergy.com/zh/projects/244. Accessed January 10, 2021.

Note-16. Actually, from 2014 to 2017, 43% of China's policy bank loans including the National Development Bank and the Export-Import Bank for the "Belt and Road countries" investment in the energy sector went to oil and gas with the petrochemical project, 18% went to coal-fired power projects, while solar projects and wind power projects received only 3.4% and 2.9% of loans respectively. The total loans for coal, nuclear and

hydropower are almost seven times the total of solar and wind projects. In contrast, 25% of the World Bank's energy loans are for renewable energy (excluding large-scale hydropower and renewable/fossil energy hybrid projects). This is available at NRDC website and World bank dataset https://www.nrdc.org/experts/han-chen/greener-power-projects-belt-road-initiative-bri, accessed at this website 16 May, 2020. https://www.worldbank.org/en/news/feature/2014/09/05/boost-in-world-bank-renewable-energy-lending, World Bank Group Energy lending focuses on poorest regions-boost in renewable energy financing, September 9, 2014. Accessed at this website 8 June, 2020.

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