Mitigation and Adaptation Strategies for Global Change (2019) 24:735–748
https://doi.org/10.1007/s11027-018-9828-6

ORIGINAL ARTICLE

Greening the one belt and one road initiative

Fan Yang[1] · Ming Yang[2]

Received: 31 August 2018 / Accepted: 10 September 2018 / Published online: 25 October 2018

Abstract
Aiming at investing in infrastructure far across the distance and spaces in continents, the One Belt, One Road (OBOR) initiative has the potential to transform transportation, urbanization, trade, and employment from East Asia to Central Asia, Europe, Africa, and beyond. With this initiative, low-income and emerging economies in these regions that have substantial dependencies on primary economic activities are likely to experience massive urbanization and associated environmental impacts such as unwanted immigration, regional air/water pollution, and carbon emissions. In the long term, negative unforeseen consequences to local and global environments can severely undermine the credibility of the OBOR and its participating countries. In the paper, we focus specifically on the energy sector, using the Port of Baku in Azerbaijan as a case study, to demonstrate the impact of greening infrastructure investments in the OBOR. After presenting the business as usual scenario for future energy consumption in the Port of Baku, namely using fossil fuel to power the Port, we present a port-greening scenario, namely using wind energy to power the Port. The results show that if a small portion of funds, namely 5% of total investment, is added on the top of total capital investment budget for new renewable energy investments, the Port will become green, and each dollar of the marginal greening investment can lead to 424 kg of carbon dioxide (CO2) reduction. If the case is applicable to 10% of infrastructure investments under the OBOR, a total of $20 billion is needed, and the marginal investments will likely mitigate a total of 8.48 billion tonnes of CO2.

Keywords Green infrastructure · Wind farm in the Port of Baku · Carbon emission reductions through foreign direct investment

✉ Fan Yang
fyan07@gmail.com

Ming Yang
ming.yang7@gmail.com

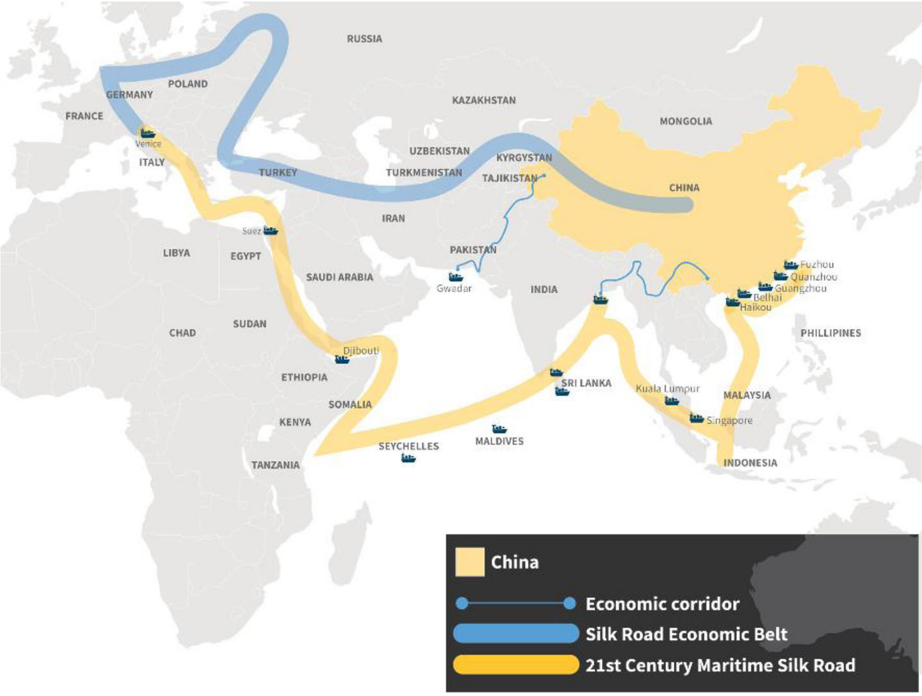
[1] University of Delaware, Newark, DE, USA

[2] International Fund for China's Environment, Washington, DC, USA

1 Introduction

The Silk Road Economic Belt and the 21st-century New Maritime Silk Road, known as One Belt, One Road (OBOR) initiative, is a foreign policy proposed by the Chinese President Xi Jinping in 2013 (Fig. 1). The objective of the OBOR initiative is to strengthen Beijing's economic leadership through a vast program of infrastructure building throughout China's neighboring countries to Central Asia, the Middle East, Africa, and Europe. The initiative spans overland and across the oceans, covering 4.4 billion people, involving 68 countries which contribute to over 40% of the world's gross domestic products (GDP). The initiative is the most ambitious foreign policy in China's history framed on the basis of facilitating trade, finance, infrastructure investment, and greater integration among the countries involved. The OBOR initiative covers multiple sectors including industrial manufacturing, utilities, materials, finance, and energy. Xi announced China's initial commitment to spending $900 billion to fund the initiative (Bruce-Lockhart 2017). As of July 2016, 900 deals worth $890 billion investments were under way, including a gas pipeline from the Bay of Bengal through Myanmar to south-west China and a rail link between Beijing and Duisburg, a transport hub in Germany. China said it will invest a total of $4 trillion cumulatively in OBOR countries.

Investing such a huge amount of capital in multiple countries requires both governments' and banks' commitments. There are at least 27 (mostly the Chinese government-owned) banks involved in the OBOR initiative (WWF and HSBC 2017). These institutions usually provide loans for projects in OBOR countries tied to certain conditions. Most typically, these conditions require that Chinese firms take part in the construction of the financed asset and/or that



Source: Bruce-Lockhard (2017)

Fig. 1 One Belt and One Road

the loan provider gains equity in the asset, and sometimes even the entire asset. Many loans are also backed via commodities in the recipient countries, such as oil, minerals, or cocoa (Kirchherr et al. 2016 and Manyuchi 2016). Unfortunately, to the global environment, many of these loans are not accompanied with global environment safeguards.

As such, China's multi-trillion-dollar investments may cause considerable issues in global environment degradation. Industrialization and urbanization in other OBOR countries due to the huge investments will convert non-urban or non-industrial land use to urban and industrial/commercial land use. Farmers will become urban residents; new roads and ports will be built; more vehicles and ships will be made and used; more energy will be consumed; and eventually, more CO2 will be emitted if low carbon energy technologies are not put as priority in the OBOR initiative.

The objective of this article is to review the infrastructure investment of the OBOR initiative from the perspective of global environment conservation. We used the following approaches in our research: (1) highlighting the potential impact of the OBOR on global environment; (2) stressing the opportunities for greening the initiative; and (3) undertaking a quantitative analysis with a case study. The case study demonstrates the development of the Port of Baku of Azerbaijan with a business as usual scenario and a greening the Port scenario, which is supported with detailed methodologies. The case study results show that a green investment in a 45 MW wind power capacity can meet the increased electricity demand of the Port while contributing to 7.4% of Azerbaijan's CO2 emission reduction target in the Nationally Determined Contributions (NDCs) of the country by 2020. This green investment will catalyze and scale up the country's greening investment for the 1000 MW power generation by 2020 and beyond. This article also shows that an OBOR-led greening initiative funded with only 5% of the total budget can have significant global environmental benefits.

2 Potential impact of the OBOR on global environment

China's OBOR initiative came with both environmental concerns and opportunities. Requesting for environmental impact assessments at the policy, strategy, and planning phases, China highlighted that the OBOR initiative will become an opportunity for the country to help developing countries improve their environmental institutional capacity. In 2017, the Chinese Xin Hua News Agency stressed 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." However, China's good will to improve global environment may not be achieved in a straightforward manner in the OBOR initiative.

First, the OBOR initiative was in part designed to absorb China's surplus production capacities in power, steel, and cement and to boost the domestic economy. This will continue a carbon- and pollution-intensive economic model rather than helping the country prevent itself from its dependence on heavy industry. In the short run, China's CO2, nitrogen dioxide (NO2), and sulfur dioxide (SO2) emissions from the power, steel, and cement sub-industrial sectors that are linked to the OBOR initiative will surely increase. From the long run, with further investment in the OBOR countries, China's surplus production capacities in power, steel, and cement may be transplanted or relocated to these countries. Without appropriate international governance, the total global environment benefits may not increase although China may significantly gain domestic environment benefits.

Second, the OBOR initiative will likely trigger massive carbon emissions beyond the power, steel, and cement sub-industries in participating countries. A major focus of the OBOR initiative is to develop infrastructure with and for fossil fuel resources. This includes constructing a new oil pipeline cutting through Myanmar and building several coal-fired power plants in Pakistan and across Southeast Asia. These investments could build fossil fuel dependency in the region even as China trumpets green energy development domestically.

Third, some Chinese projects have been known already to spawn pollution problems in the past, such as NO2 and Water pollution from Chinese mining in Ghana (Hirsch 2013) and forest damage in Sierra Leone (AsiaNews IT 2008). Worries about damage to ecosystems in local communities have compromised Chinese overseas development plans in the past. For instance, the Myitsone Chinese dam project on Myanmar's Irrawaddy River was suspended due to concerns on dam's damages on the local ecosystem. China may need to use international environment safeguard policies and measures while developing and investing infrastructure projects in the OBOR countries.

Fourth, the OBOR initiative is triggering urbanization and industrialization in ports and stations that are linked to the initiative. Industrialization means manufacturing in factory settings using machines plus laborers who are likely transformed from farmers. Stimulated urbanization means the growth of new cities in both population and physical size. From the environment perspective, the industrialization and urbanization in the OBOR initiative will cause transformational impact or changes in land use, biodiversity, forests, water use, and other natural resources in all participating countries. In the meantime, the OBOR initiative brings new opportunities to green economy in all OBOR participating countries for sustainable development.

3 Opportunities for greening the initiative

Over the past decade, China has been leading in the development and investment in clean energy and green infrastructure technologies. Through a combination of subsidies, policy targets, and manufacturing incentives, China has spent more on cleaning up its energy system than the US and the EU combined. In 2017 alone, China invested a total of $132.6 billion in clean energy financing, which is 39.7% of the world total amount (Bloomberg 2017). As a result, China had one-third of the world's wind power, a quarter of its solar capacity, six of the top ten solar-panel manufacturers and four of the top ten wind-turbine makers (IEA 2017). China sold more electric vehicles than the rest of the world combined and it led the world in construction of nuclear power plants in 2017. In December 2017, China launched the world's largest carbon-trading scheme. More importantly, China is willing to export its new renewable energy technologies to other developing countries via its south-south cooperation strategy and OBOR initiative.

3.1 China's solar PV technologies

China started solar PV development with government subsidies from its Seventh Five-Year Plan (1986–1990). The development was on a very small scale and it did not have a significant impact until 2000. During the first decade of the twenty-first century, however, China's solar PV industry boomed with tremendous speed. In that period, the global economy ran very well; many countries in Europe and North America were expanding solar PV installation capacities. With high international demand in the highly profitable market, many solar PV companies were established in China to make solar PV modules for export to Europe and the US. Many local Chinese governments encouraged more capital investment to enlarge local GDP and increase tax revenue. Increasing economies of scale have been constantly pushing down the project costs per unit of solar PV capacity, which has made the solar PV technology competitive against conventional coal fired power plant technologies. Over the past few years, China's PV installed capacity has continued to expand and has become the world's largest application market. The newly installed capacity of solar PV power generation has ranked the first in the world for five consecutive years from 2012 to 2017, and the cumulative installed capacity has ranked first in the world for three consecutive years from 2014 to 2017. As of the end of April 2018, the cumulative installed capacity of solar PV power generation in China has exceeded 140 GW, which is equivalent to the total capacity of 6.2 Three-Gorges Hydropower Plants in China (People's Daily 2018). In the meantime, China's production capability for solar PV is scaling up and expanding, while technologies and product quality are also constantly improving. In 2017, the production capacity reached 75 GW, accounting for 71% of the world. Of the worldwide top 10 solar PV module production companies, eight are in China (People's Daily 2018). Silicon-based solar technologies in China will continue to be the mainstream product for large-scale electricity generation application in the near future. With module efficiency reaching as high as 23% and production cost as low as \$0.24/W, the levelized cost of electricity (without subsidies) for solar will be around \$34/MWh, allowing solar PV to be competitive with traditional energy resources like coal (Long et al. 2018).

3.2 China's wind power technologies

China's wind power technologies have been developing faster than expected. By the end of 2016 when China's wind power capacity reached 149 GW, the National Energy Administration of the National Development and Reform Commission of China adopted the Chinese government's wind energy development plan that was made in the 13th Five-Year Plan (2016–2020) of the Chinse government. The goal of the plan is to develop a total of 210 GW of wind power, including 205 GW onshore and 5 GW offshore by 2020. If the investment target is achieved, China will generate 420 TWh of wind energy, accounting for about 6% of total electricity generation by 2020. By the end of 2017, China's wind power generation capacity totaled 188.4 GW of wind power generation capacity, with about 40 GW net increase in one year, and generated 328 TWh of electricity from wind energy, representing 5% of total national electricity generation (6558 TWh) (GWEC 2018). With this growth rate, China will reach its 2020 target of wind power development in 2018, two years ahead of the planned schedule. The main drivers of accelerated investment and deployment in wind power include technology advancement and mass production of wind turbines, which cut down the average cost of Chinese turbine production by 56% in the period of 10 years from approximately \$2000/kW in 1996 to about \$880/kW in 2016 (IRENA 2018). In the long-run, the Chinese government has made a road map for wind power up to 2050 to have a total of 400 GW by 2030 and 1000 GW by 2050. China has indeed identified wind power as a key growth component of the country's economy, which can also benefit other countries in the OBOR initiative.

3.3 China's south–south cooperation strategy and experience

South–south cooperation (SSC) is a term to describe the exchange of resources, technologies, and knowledge between developing countries most of which are in the South. Often under-reported and sometimes hard to quantify, the estimated value of SSC services has exceeded US$20 billion in 2013; and capital investments mobilized from the private sector through SSC totaled more than US$700 billion in 2014, a 4% increase from 2013 (UN 2016). China has become one of the largest SSC providers, and is playing an increasingly important role in global forums such as climate change and global trade negotiations. Examples of China's SSC include (1) Brazilian Civil Society Organizations (CSOs) that have initiated projects with CSOs from Colombia, India, China, South Africa, and Thailand to share knowledge and experience on access to HIV/AIDS treatment (UNDP 2013); (2) Between January 2003 and June 2014, China's foreign direct investment (FDI) created 64,201 jobs in sub-Saharan Africa, according to the database produced by fDi Intelligence[1] (Pigato and Tang 2015). It is estimated that the entire manufacturing industry in China employs 85 million to 150 million jobs. During the upcoming industrial transformation in China, most of these jobs will possibly be transferred to Africa. Currently, developing countries which are undergoing economic transformation to upgrade their industrial systems will create unprecedented job opportunities for labor-intensive industries in low-income countries in Africa (Lin 2013). The OBOR initiative will facilitate SSC and transfer jobs to participating nations.

3.4 Application of China's green technologies in OBOR countries

China can make good use of its green technologies and south-south cooperation to mitigate the impact of the OBOR on global environment:

1. China can help other countries to develop or set international green standards and codes for transport and energy infrastructure that will be enforced and implemented during the OBOR investments.
2. Disseminate China's innovative business models in the OBOR countries. For example, many countries in Central Asia and the Middle East are suffering from water shortages, loss of forest and biodiversity, and land degradation. China's OBOR initiative can facilitate member countries to use solar PV to pump underground water for agriculture and other vegetation plantation in new cities and towns that will be developed along with the Belt and the Road.

4 Case study on the port of Baku

4.1 Background

As a landlocked country, Azerbaijan needs to develop intermodal transport infrastructure integrating the sea and land transport modes so that the country can access to the Caspian Sea markets. Surrounded by Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan, the Caspian Sea is the largest inland sea in the world. These five countries are the main maritime traders in the Caspian region. In addition to bilateral trade, the great proportion of trans-Caspian trade consists of transit shipments. More than 80% of cargo processed at Azerbaijan's Caspian ports and terminals is made up of transit goods in 2015. The freight turnover at the Port of Baku in the first half of 2017 made 1.9 million tonnes, growth by 43.5% comparing to

[1] A division of The Financial Times specializing in tracking FDI investment projects worldwide.

the first half of 2016, excluding oil and oil products. Some 89% of all cargo transportation fell on transit goods (Azernews 2017).

With its strategic location, Azerbaijan has the potential to become a major transit center for goods flowing between Europe and Central Asia. The construction of a new Baku International Sea Port is central to this vision. The new Port of Baku could be located on a 400-ha (ha) plot, near the coast township of Alyat, about 70 km south of Baku. Of this 400-ha plot, 100 have been planned to build a free-trade zone (FTZ). The Port's site offers natural protection against waves and longshore drifts by the Gil Island a few kilometers offshore, which means that the construction of a breakwater is not required.

More generally within Azerbaijan, modes of transport for freight traffic are composed of road (48.8%), railway (16.7%), pipelines (28.3%), and sea (6.1%). The government of Azerbaijan has been making very large investments nationally, totaling US$13 billion from 2010 to 2015 in roads, railways, and other infrastructure. Azerbaijan is an active participant in the Transport Corridor Europe-Caucasus-Asia (TRACECA) initiative, funded by the EU, which aims to develop a multi-modal transport system to promote economic and trade relations.

A new route through Caucasus will likely be added to the various corridors of the OBOR initiative. In April 2017, Kazakhstan, Azerbaijan, and Georgia signed a protocol on a future Trans-Caspian International Transport route. Other regional countries such as Ukraine and Uzbekistan may join this initiative. This project was launched in 2013 and the line has been tested several times since 2015. The Caspian Sea route from Khorgos in the Chinese province of Xinjiang to the Port of Piraeus in Greece where China has massively invested, via the Caspian Sea and the Black Sea, could prove faster than continental railway lines passing through Russia. But to make this route effective, Caucasian countries and Kazakhstan must modernize their infrastructures and coordinate their efforts. This road could strengthen China's presence in the Caucasus and will provide an opportunity for Caucasian countries to better connect with China and Europe. This new route will enable the revitalization of the major ports of the Caspian Sea, namely Baku in Azerbaijan and Aktau in Kazakhstan, and also those in the Black Sea. In May 2017, China and Georgia signed a free-trade agreement that is expected to enter into force in 2018. The ports of Constanta in Romania and Burgas in Bulgaria may also be integrated into this new network. A better connection of these ports to European rail networks should therefore be considered. Furthermore, European companies will have to remain attentive to the investment possibilities that the new Caucasian road would create. In short, the development of the Port of Baku of Azerbaijan has geopolitical and long term strategic significance for China, Azerbaijan, and other Caucasus countries.

Similar to other emerging economies, Azerbaijan's growth path was affected by the global financial crisis. The boom in oil prices prior to the crisis led to a marked increase in FDI and public spending. In conjunction with the implementation of economic reforms that raised productivity, economic growth was projected to be over 10%. However, as of 2012–15, the economy's long-term growth projection was lowered to around 3%, and continued dependence on hydrocarbon exports was seen as a major vulnerability going forward (IMF 2016). To ensure sustainable growth, the government has been developing a strategy to rapidly diversify the economy by creating a more business-friendly environment and pursuing structural reforms. With potential Chinese financing support, the OBOR initiative provides Azerbaijan with a unique opportunity to invest in the non-oil economy that can yield long term economic and environmental benefits (Fig. 2).

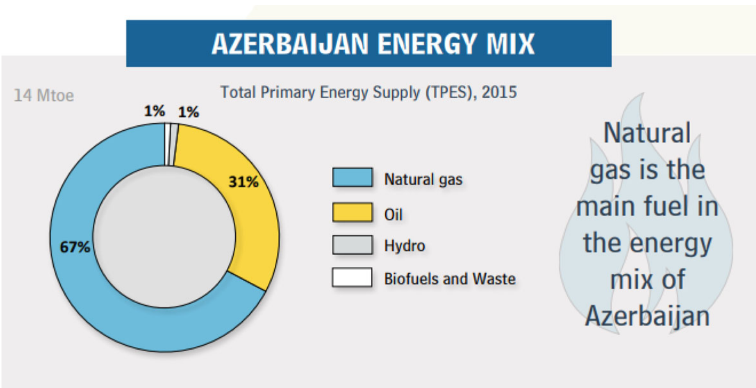
Source: OBOR Europe (2018)

Fig. 2 The Port of Baku in OBOR

4.2 Energy in Azerbaijan

Azerbaijan is rich in energy resources including oil, gas, solar, and wind energy. According to BP (2017), Azerbaijan oil's reserves were estimated at one billion tonnes and natural gas reserves 1.1 trillion cubic meters (TCM) as of the end of 2017. The country produced 41 million tonnes of oil and 17.5 billion cubic meters of gas; it consumed 4.6 million tonnes of oil (11% of production) and 10.4 billion m^3 (59.4% of production) of natural gas; and exported the remainders in 2017. At the current rates of oil and gas productions, this country will run out of oil resources in 24 years and natural gas resources in 63 years. With 98% of total primary energy supply originating from fossil fuel (see Fig. 3), Azerbaijan needs to search for alternative energy resources.

Fortunately, Azerbaijan has huge unharnessed renewable energy resources. The annual period of sunlight reaches 2500 h in the Absheron Peninsula and Caspian Sea coast, and 2900 h in the Nakhchivan Autonomous Republic. The speed of wind changes between 3 and 7 m/s in a year which is considered perfect for wind power generation. Evidently, Azerbaijan



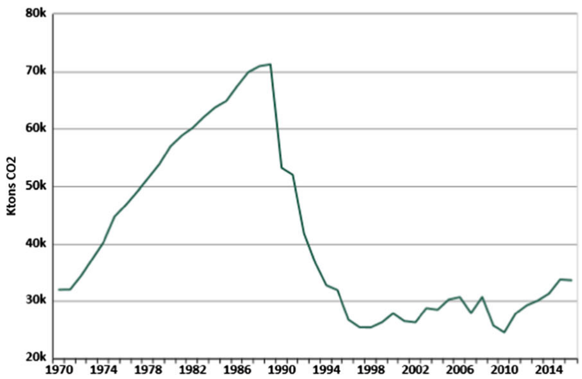
Source: IEA (2017)

Fig. 3 Energy mix in Azerbaijan

has two options or policy scenarios in its future energy development: (1) continually depending on oil and gas; and (2) investing in new renewable energy for green development.

4.3 Greenhouse gas emissions from Azerbaijan and Port Baku

In its NDCs that were submitted to the United Nations Framework Convention on Climate Change (UNFCCC), Azerbaijan targeted to reduce 25.6 million tonnes of CO2 or 35% at the level of 1990 base year (73.3 million tonnes) by 2030 as its contribution to the global climate change efforts (Azerbaijan 2015). From 1990 to 1998, CO2 emissions in Azerbaijan decreased from 71.2 million tonnes to 25.4 million tonnes. Over the past 20 years, the total emissions were fluctuating and gradually increasing from 24.5 million tonnes in 2010, to 33.6 million tonnes in 2016. To achieve the targets in the NDCs, the country needs to develop and use green energy in its energy intensive sector over the next decade.



Date	Value	Change, %
2016	33,614.2	-0.41 %
2015	33,752.8	7.82 %
2014	31,303.5	4.03 %
2013	30,090.8	2.92 %
2012	29,237.3	5.23 %
2011	27,784.7	13.25 %
2010	24,533.9	-4.53 %
2009	25,698.7	-16.33 %
2008	30,712.6	10.16 %
2007	27,879.9	-9.14 %
2006	30,683.1	1.40 %
2005	30,258.5	

Source: Knoema (2018)

The transport sector in Azerbaijan is energy intensive and greenhouse gas (GHG) emissions in the sector have been rapidly expanding since early 2000. According to the country's second national communication to the UNFCCC, freight transport demand has increased 4.8-fold from 15,000 million tonnes-km in 2000 up to 88,000 million tonnes-km in 2008 (Azerbaijan 2010). With implementation of an ambitious new Port of Baku project without any approach to greening the Port, the level of transport-related GHG emissions in Azerbaijan will increase many fold in proportion to the expected increase in freight and passenger turnover in the Port and its logistics center. In addition to GHG emissions, activities at ports cause an array of environmental impacts that can seriously affect local communities and the environment. These impacts range from increased risk of illness, such as respiratory disease or cancers, to increases in regional smog, degradation of water quality, and the blight of local communities and public lands.

There are very limited data and information to estimate the current and future carbon footprint of the Port of Baku due to the absence of environmental data collection and management system at the Port. With the best knowledge of existing data, one can estimate GHG emissions from the ports with three main sources: a) on-site emissions from energy use by port-owned vehicles, buildings, and other stationary sources; b) on-site emissions by port tenants and users, such as ships, trucks, and cargo-handling equipment; and c) off-site emissions for production of electricity for port operations. By comparing projected cargo and passenger turn-over with other international ports in Europe and the US where data about their GHG inventory are available, it is possible to estimate the range of the new the Port of Baku's annual carbon footprint (Coto-Millán et al. 2010). Other important information such as the size and type of infrastructure of the new the Port of Baku, possible CO2 intensity based on different kinds of primary energy consumption scenarios were also studied and estimated to calculate the carbon footprints and tonnes of cargo/tCO2e etc. Given the existing data shortage situation, the authors designed a special methodology to calculate GHG emission reductions due to greening the Port of Baku.

4.4 Methodology for GHG emission reduction calculation

4.4.1 Two scenarios

The GHG emission calculation methodology has two major components—baseline scenario and project scenario. Baseline scenario is defined as what will happen without greening the project, i.e., in the business-as-usual scenario. The development of power generation capacity and provision of energy will continue with the existing "marginal technologies." Typically, these technologies are based on coal, oil, or natural gas for power generation, since Azerbaijan is rich in fossil fuels, which will surely lead to increase of GHG emissions. The baseline scenario needs to specify technologies and the amount of investment necessary. To assess how much investment would have been necessary in the baseline scenario case, it is important that the comparison is based on useful energy output, and not on the generation capacity provided.

The project scenario is defined as what will happen with greening the project. With the investment of greening technologies, the use of fossil fuel based-technologies will be avoided or postponed. Typically, these greening technologies use wind, solar, small hydro, and biomass as primary energy for power generation. In this case study for the Port of Baku of Azerbaijan, we will focus on wind power development, although there is plenty of solar energy available in Baku.

4.4.2 Calculating emission reductions

The calculation of the direct emission reductions for renewable energy projects is based on the marginal technology of the project. The formula applies in a straightforward manner:

$$\text{CO2 reduction} = E^{*}c = e^{*}l^{*}c;$$

where

CO2 reduction	GHG emission reductions in tonnes of CO2 eq
E	cumulative energy produced by renewable energy, e.g., in MWh; $E = \Sigma\, l * e$
c	CO2 emission factor of the marginal technology, e.g., in tonnes/MWh
e	annual energy replaced, e.g., in MWh
l	average useful lifetime of equipment in years

The baseline CO2 emissions are based on the emission factors and conversion efficiencies typical for new fossil fuel generation, and the energy output provided by the greening investment into renewable energy. To be consistent across projects and reduce the number of assumptions necessary, cumulative emission reductions for a greening project are calculated on the basis of the investment lifetime. It is important that the baseline scenario also account for the power production over the full expected lifetime of the renewable energy units. The typical expected lifetime for a wind turbine is 20 years.

4.5 GHG emission reduction estimation for the Port of Baku

Step 1. Determine the baseline The marginal technology in the country is oil- and gas-fired thermal generation. The country will need an additional 1000 MW of generation capacity by 2020, and it is likely that without intervention, this need will be met by oil- and gas-fired generation. An exact calculation of the baseline scenario is not needed, as the difference between the wind alternative scenario and business-as-usual scenario can be directly determined. The objective of the greening project objective is to diversify power generation in the Port of Baku with the development of a wind energy. The greening project scenario is assumed to pilot a small offshore wind farm with 45 MW.

Step 2. Determine the wind project alternative With the support of the OBOR wind project, in the next three-years, up to 45 MW of wind capacity will be supported through capacity building and financing that would not have occurred without the greening project. This will foster the beginnings of the transformation of the energy market toward what is more conducive to wind energy. Financial commitments will be put in place up until 2021 for the 45 MW investment. Direct emission reductions will result from these activities.

Through the project's development of the pilot wind power in the country, wind energy will receive a green power premium, increasing the competitiveness of wind generation vis-à-vis oil or gas power. This will catalyze the greening investment for the 1000 MW power generation for the country by 2020 and beyond.

Step 3. Calculating emissions reductions GHG emission reductions can be calculated by using the formulas that were shown in the previous section of the paper. First, the amount of energy generated by investments made during the project must be calculated. In this project, energy generated is reported in the form of MWh. Installing grid-connected wind power provides a substitute for electricity supplied from other sources to the national grid, currently comprised predominantly of oil- and gas-fired power generation. Initial research conducted as part of the project planning process notes that wind farms in the Baku area will operate with a capacity factor of 27%—that is, over the course of a year, 1 MW of capacity would yield 2365 MWh (i.e., 1 MW $*$ 8760 h $*$ 27%). As a result, 45 MW of grid-connected wind capacity will be installed. Thus, the total installed capacity of 45 MW will generate 106,425 MWh per year, or 2130 GWh over its default lifetime of 20 years.

To obtain the CO2 emission reductions, the cumulative grid-supplied electricity saved due to the installation of wind generation capacity, and the CO2 emission factor of the grid supplied electricity, are multiplied together. Initial research conducted for the Port of Baku has determined the average CO2 intensity for the national grid-supplied electricity to be 0.89 t of CO2 per MWh. This means that the total CO2 emissions due to the investment of 45 MW wind power are equal to total produced wind energy multiplied by the CO2 emission factor shown as follows: CO2 reduction = $E * C$ = 2130,000 MWh $*$ 0.89 t of CO2 equivalent / MWh = 1,896,000 t of CO2 equivalent (1.896/25.666 = 7.4% of NDCs).

According to CII (2018), if Chinese power technologies were used, the levelized costs of wind power and coal-fired power plants would be \$0.067/kWh and \$0.046/kWh in 2017, with a difference of \$0.021/kWh (or \$21/MWh). CII (2018) also indicates that by 2020, the cost of wind power will become the same as that of coal-fired power plants; by then, wind would have become cheaper than coal-fired power plants due to increasing costs of fossil fuels over time. If the authority of the Port of Baku invests in wind power today rather than in coal-fired power plants, it will likely pay an additional cost of \$4.47 million (106,425 MWh/year ∗ 20 years ∗ \$21/MWh).

Given two numbers: (1) \$4.47 million additional capital investment is needed to convert a coal-fired power plant to a wind power plant, and (2) 2130 GWh of green electricity is generated from a 45 MW wind power plant in 20 years, we can easily derive the following result: whenever one additional dollar is invested to green the Port of Baku, generation of 476.5 kWh of electricity can be changed from a coal-fired power plant to a wind power plant. Every dollar in greening investment will likely avoid 424 kg of CO2 emissions.

If the case study of greening the Port of Baku is applicable to all energy infrastructure projects of the OBOR, in the business as usual scenario, the total investment for a coal-fired power plant can be estimated at \$90 million, at the cost of \$2000/kW for the coal-fired power plant (50%) and coal-infrastructure investments (50%). The greening investment of \$4.47 million is approximately 5% of the total. If this percentage is applied to 10% of capital investments of the OBOR, a total of \$20 billion (\$4 trillion ∗ 10% ∗ 5%) is needed to green the whole OBOR Initiative, which implies the mitigation of a total of 8.48 billion tonnes of CO2.

5 Conclusion and implication to greening the OBOR initiative

While the monumental OBOR initiative has the potential to transform infrastructure, trade, and employment from the East Asian region to the Central Asia, Europe, Caucasus, Africa, and beyond, it will likely do so with considerable impact on both domestic and global environments and societies where it passes through. This impact can be positive and negative, depending on which technologies are to be deployed and which natural resources are to be used. On the one hand, with its surplus production capacities in iron, steel, cement, and other heavy industrial products, China can easily help build coal- or oil- fired power plants and other fossil energy intensive infrastructure for the OBOR participating countries. On the other hand, with its increasingly advanced new renewable energy technologies, China can make the OBOR initiative green. Although the totality of the social and global environmental impacts that will accompany the timeline of the OBOR initiative warrants further research and analysis, the simple case study in this paper has demonstrated the potential for a small-scale greening project in Baku Port of Azerbaijan to be considered in the next few years.

Naturally endowed by both rich fossil fuels and abundant renewables, the Baku Port can be powered by either carbon intensive or zero- or low-carbon technologies. With only a 5% additional capital cost to transform the energy investment from fossil fuel-based power generation to wind power, the Port will become green. The total capital investment in a 45-MW wind farm in the coastal area of Baku Port will contribute to 7.4% of carbon emission reduction that was targeted in Azerbaijan's NDCs.

China's green investment in Baku Port will likely catalyze Azerbaijan's green its infrastructure. In the long term, oil and gas reserves are limited in supply, and in the short term, overdependence on exports can bring unwanted volatilities into the domestic economy. Azerbaijan must diversify its economy in the non-oil sector while continuing its integration into the global value chain. Clearly, a move toward green investments in infrastructure has benefits beyond reducing CO2 emissions; while the OBOR initiative can foster Azerbaijan's green economic development. A focus on renewable energy and other green measures can develop local capacity, create employment, and create avenues for cooperation in other sectors. China and Azerbaijan can both directly benefit from south-south cooperation, while international credibility can be strengthened for both governments through the success of green pilot projects.

Greening infrastructure investments in the OBOR initiative will have magnificent impact in carbon emission reduction globally. If all transportation infrastructures with the OBOR can be greened, a total of 8.48 billion tonnes of CO2 can be mitigated with the green investment capital of $20 billion.

We recommend that governments, development banks, commercial banks of China, and OBOR beneficiary countries jointly set and implement global environment safeguards in their loan lending and borrowing. If an additional 5% of capital investment can make any infrastructure investment project green, the investment deal should be made toward greening directions.

References

AsiaNews IT (2008) Chinese thrown out of Sierra Leone for destroying local forests 01/16/2008, AsiaNews IT. http://www.asianews.it/news-en/Chinese-thrown-out-of-Sierra-Leone-for-destroying-local-forests-11266.html

Azerbaijan (2010) 2nd National Communications to the United Nations Framework Convention on Climate Change. https://unfccc.int/resource/docs/natc/azenc2.pdf. Accessed on May 11, 2018

Azerbaijan (2015) NDC – Nationally Determined Contributions to the UNFCCC (2015). http://www4.unfccc.int/ndcregistry/PublishedDocuments/Azerbaijan%20First/INDC%20Azerbaijan.pdf. Accessed on May 7, 2018

Azernews (2017) Brief overview of some Caspian ports freight turnover. https://wwrw.azernews.az/business/124194.html. Accessed on June 11, 2018

Bloomberg (2017) State of clean energy investment- new energy finance, https://about.bnef.com/clean-energy-investment/

BP (2017) Statistical Review of World Energy in June 2017. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf. Accessed on May 7, 2018

Bruce-Lockhart, A (2017) China's $900 billion new silk road. What you need to know, World Economic Forum. https://www.weforum.org/agenda/2017/06/china-new-silk-road-explainer/

CII - Chinese Industrial Information (2018) The status quo and future development prospects of China's wind power industry in 2017. http://www.chyxx.com/industry/201801/598998.html. Accessed on June 12, 2018

Coto-Millán P, Pesquera M, Castanedo J (eds) (2010) Essays on port economics. Heidelberg, New York ISBN 978-3-7908-2425-4

GWEC – Global Wind Energy Council (2018) Global statistics http://gwec.net/global-figures/graphs/. Accessed on May 3, 2018

Hirsch A (2013) Influx of Chinese goldminers spartensions in Ghana https://www.theguardian.com/global-development/2013/apr/23/influx-chinese-goldminers-tensions-ghana

IEA (2017) Azerbaijan energy factsheet. http://www.iea.org/countries/non-membercountries/Azerbaijan/Azerbaijan_EU4Energy_Factsheet.pdf

IMF (2016) IMF Country Report No 16/296. Accessed at: http://www.imf.org/en/Countries/AZE#ataglance

IRENA (2018) Renewable Power Generation Costs in 2017. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf. Accessed on May 3, 2018

Kirchherr J, Disselhoff T, Charles K (2016) Safeguards, financing, and employment in Chinese infrastructure projects in Africa: the case of Ghana's Bui Dam. Waterlines 35:37–58

Knoema (2018) Azerbaijan - CO2 emissions https://knoema.com/atlas/Azerbaijan/CO2-emissions. Accessed on May 10, 2018

Lin J. (2013) Africanized Chinese manufacturing industries. Press of Magazine Caijing. http://www.qikan.com/article/E6B94D0C-6276-413A-987E-9FF50056CCFB

Long L, Lee B, Azevedo L (2018) A sunny future: expert elicitation of China's solar photovoltaic technologies. Environ Res Lett 13:034038 IOP Publishing Ltd

Manyuchi AE (2016) Foreign direct investment and the transfer of technologies to Angola's energy sector. Afrika Spectrum 55:51–83

OBOR Europe (2017) The Caucasus route. http://www.oboreurope.com/en/caucasus-route/. Accessed on May 7, 2018

People's Daily (2018) Continue to support the sustainable and healthy development of the Solar PV industry, June 12, 2018, in Chinese. http://www.gov.cn/zhengce/2018-06/12/content_5297974.htm

Pigato M., Tang W (2015) 'China and Africa: expanding economic ties in an evolving global context.' Investing in Africa Forum, World Bank, Africa. https://www.worldbank.org/content/dam/Worldbank/Event/Africa/Investing%20in%20Africa%20Forum/2015/investing-in-africa-forum-china-and-africa-expanding-economic-ties-in-an-evolving-global-context.pdf. Accessed on May 3, 2018

UN - United Nations (2016) Review of progress made in implementing the Buenos Aires plan of action, the new directions strategy for south-south cooperation and the Nairobi outcome document of the high-level United Nations conference on south-south cooperation, New York, 12 March 2016 (SSC/19/1), pg.2

UNDP (2013) Working with Civil Society in Foreign Aid: possibilities for south-south cooperation? Beijing, China, 2013

WWF and HSBC (2017) Greening the belt and road initiative: WWF's recommendations for the finance sector – in conjunction with HSBC. https://www.sustainablefinance.hsbc.com/our-reports/greening-the-belt-and-road-initiative. Accessed on September 9, 2018