

## China and the change of the energy matrix in Latin America: a global political economy approach

*China e a mudança da matriz energética na América Latina: uma abordagem de política econômica global*

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RESUMO: A China lidera a mudança global da matriz energética e o faz principalmente na América Latina. Essa mudança questiona a posição e a liderança dos Estados Unidos em geral e, particularmente, na América Latina. As evidências mostram que os Estados Unidos estão atrasados na mudança energética em termos técnicos e institucionais e estão fortemente ancorados na energia suja. As evidências também mostram que os EUA não estão permitindo o avanço da China na região facilmente. A geração de energia a partir de fontes de energia limpa está em ascensão, com a China liderando em equipamentos solares e barragens hidrelétricas, enquanto compra redes de distribuição elétrica de empresas norte-americanas. As consequências para a economia global serão sentidas em muitas frentes, desde a mudança no sinal da balança comercial e diminuição da inflação até realinhamentos de moeda e remodelação do poder com o colapso dos preços do petróleo.

PALAVRAS-CHAVE: Desenvolvimento econômico; comércio e meio ambiente; relações internacionais; inovação aberta; política governamental.

ABSTRACT: China is leading the global change in the energy matrix and mainly Latin America. This change questions the position and leadership of the United States in general and particularly in Latin America. Evidence shows that the United States lags in energy change in technical and institutional terms and is anchored heavily in dirty energy. Evidence also indicates that the US is not allowing China to advance in the region quickly. Power generation from renewable energy sources is rising, with China leading in solar equipment and hydroelectric dams while buying out electric distribution networks from US firms. The consequences for the global economy will be felt on many fronts, from the balance of trade sign

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change and decreased inflation to currency realignments and power reshuffle as oil prices collapse.

KEYWORDS: Economic development; trade and environment; international relations; open innovation; government policy.

JEL Classification: F6; O1; F18; F5; O36; O38.

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## INTRODUCTION

This article aims to show how China is leading the change in the global energy matrix, and it's doing so, particularly in Latin America. This change in the energy matrix questions the position and leadership of the United States in general and Latin America, particularly to the extent that oil exports are strongly led by oil. Secondly, the US automotive trade, a determinant for that economy, is affected as long as the US does not change its automotive energy matrix, given consumer awareness of the environmental problem. There will be an impact on the economies of Mexico and Canada, both articulated to the US producing fossil fuel energy vehicles. At the same time, China leads in the manufacture of electric cars. There will also impact the balance of payments of oil-exporting countries in general and some Latin American ones, particularly Mexico, Trinidad and Tobago, Venezuela, Colombia, Ecuador, and Bolivia. However, evidence shows that the United States is lagging in energy change and is anchored heavily in fossil fuel energy. Renewable energy vehicle production will accelerate the energy matrix change process in the medium term. Power generation from renewable energy sources is rising, with China leading in solar equipment and hydroelectric dams. The consequences for the global economy will be felt on many fronts, from the balance of trade signs and decreased inflation to currency realignments and power reshuffles. This paper will analyse the energy change from a global political economy standpoint to see the consequences worldwide in the long term.

## CHINA, ITS ENVIRONMENTAL POLICY, AND THE CHANGE IN THE ENERGY MATRIX

Environmental pollution has been an issue of concern to the Chinese government, whose health problems from coal, manure, and wood for cooking and coal for electricity generation have caused severe health problems. With growth rates of more than 10 percent in the years leading up to 2010, air pollution problems have been on the rise since the 1990s, prompting a study of the problem and ways to address it.

The US and Chinese Academies of Science agreed to study air pollution jointly and deal with it. Together they produced the joint report *Energy Futures and Urban Air Pollution: Challenges for China and the United States* (2008), identifying

the United States and China as the world's number one and two energy consumers. The report recognises China as the largest emitter of sulphur (SO<sub>2</sub>), and both countries lead the world in carbon dioxide (CO<sub>2</sub>) due to the extensive use of fossil fuels. While the United States generates oil and gas pollution, it is clear that China does so with coal.

Here we explore three recommendations from this report. The 7th says it should: "Promote efficient transportation systems and sustainable urban design. Rapidly developing cities with high projected growth should apply a transit-oriented design and intelligent growth policy, particularly to create new urban areas or re-urbanize existing areas. The several US and Chinese cities should consider Bus Rapid Transit (BRT) as it represents low-cost transit (relative to metro and light rail) and is a system quickly adapted to existing infrastructure, with proven success in other parts of the world."

The tenth recommendation reads, "Promote renewable technologies for heat and power generation. Incentives are needed in the United States and China to implement cleaner coal conversion technologies, more efficient generation methods, and productive use of waste heat. The twelfth recommendation states, "Accelerate the development and use of renewable energy sources. Both countries should continue to promote the development, production, and use of renewable energy wherever possible, through various policy instruments."

From then to the end of the second decade of the 21st century, an energy transformation in China can be observed, with a reduction in the use of coal for electricity generation, a decrease in oil imports for electricity generation, and an increase in nuclear electricity generation, as well as the development of renewable energy technologies from lamps with photovoltaic cells to the extensive use of solar energy and the development of electric transport vehicles: trains, buses, trucks, cars. On the other side, there seems to be a hold-up in these developments in the West.

Part I, Chapter 1 of the CHINA: *12th Five-Year Plan (2011-2015)* for National Economic and Social Development, titled Development Environment, states:

It is essential to see the imbalanced, non-sustainable, and incompatible elements within China's development. These mainly turn out to be a tightened constraint between economic growth and development and resources and environment on the other.

There is an emphasis of this first consideration below:

China should enhance its research and innovation capabilities in science, technology, and management, train more innovative talent and, improve workers' education. In short, strive to accelerate the building of a country of innovation.

Additionally, in the same *12th Five-year Plan for Environmental Protection* issued in December of 2011, it has specific goals of resource conservation and environmental protection by reducing water consumption, maintaining farmland

reserves, reducing CO<sub>2</sub> emissions by 17%, with per capita energy uses shrunk by 16% and fertiliser emissions and increasing forest reserves.

Chapter 9, Section 1 of the *12th Five-year Plan*, is entitled “Improving and Promoting Manufacturing.” Here specific policies are detailed to face crucial manufacturing sectors that pollute. It seeks to improve technology and optimise energy use with alternative sources in the automotive, petrochemical, construction, and manufacturing industries.

Chapter 10 states that it will promote technological development for new environmentally friendly energy industries such as electric cars and energy conservation and the technical development of the biological industry with biopharmaceutical, agricultural and biomedical products. Likewise, it will foster the development of information and high-end technologies such as next-generation internet, aeroplanes, and satellites. The added value of the above should reach 8% of GDP.

The introduction of electric car production and enhanced Huawei 5G technology, the output of C919 aircraft, and the development of satellites like the one launched in Bolivia in 2019 result from this plan with these concrete goals. There is also a policy of productive industrial updating to place it at the forefront of renewable manufacturing and equipment that generates renewable energy. These goals are undoubtedly incorporated in the Ministry of Ecology and Environment reports and undergo regular evaluations. There is a renewable environment policy to complement renewable production and meet the goals set out in the plan. The sum of all this and its practical implementation transformed China into a leading country in the changeover of the energy matrix because it has renewable energy as a central goal of its policies (see Table 1).

In 2013, the PRC’s Ministry of Ecology and Environment published *The Airborne Pollution Prevention and Control Action Plan (2013-17)* unveiled by the State Council, introducing ten measures to improve air quality. Among them, the document mentions that the industrial plant will be optimised and modified to reduce “the discharges of multiple pollutants (p.4)”, also “controlling the newly added production capacity in energy-intensive and high-emission industries (p.4)”. The government will promote the scientific development of renewable energy, and it will implement a system of monitoring, legal, and business incentives for environmental care. Furthermore, “by 2017, the consumption of coal will be reduced to below 65% of total energy consumption (p.5)” (China State Council, 2013). The evidence shows that between 2013 and 2016, coal consumption was in decline but recovered in the following years, and by 2019 it was at the same point as in 2014, 81.7 exajoules. The country is not meeting its planned commitments and continues to pollute aggressively.

Derived from this objective of the *12th Five-year Plan*, the China Development Bank produced an annual sustainable development report starting in 2012. *The 13th Five-year Plan (2016 to 2020)* has the 2020 objective of doubling GDP per capita from its 2010 level to achieve full “national revival” by 2049, the one-hundredth anniversary of the People’s Republic of China (Aglietta and Bai, 2016). The long-term objective is to maintain the energy matrix change and strive towards

renewable energy. To this end, Chapter XI, Section 1, refers to the role of public enterprises. The aim is to make State-owned commercial businesses internationally competitive and increase their capacity for innovation to strengthen the State sector. It will improve the effectiveness of State capital, maintain or increase the value of State-owned assets, and ensure the people's well-being, serve society and provide public goods and services. All this is done through increasing market forces, introducing market mechanisms, and improving the assessment of cost control, quality, performance, and capacity of products and services. State-owned commercial enterprises should implement policies for hiring management professionals and strengthen their differentiated wage systems and incentives for innovation. China's goal is to be a leader in renewable energy and have competitive state-owned enterprises following market principles. Using World Bank data, evidence shows that GDP per capita measured either in PPP or in constant 2017 international PPP doubled between 2010 and 2019.

The 14th Five-Year Plan 2021-2025 deepens the technological objectives. It seeks "to comprehensively promote the overall design of economic construction, political construction, cultural construction, social construction and the construction of ecological civilisations". To this end, the investment will be focused on modern and green industrial development, science and technology, and the digital economy. Also, the country's openness will continue to increase with the "socialist market" economic system as the "most perfect" in the world. Remarkably, this plan focuses on changing the energy matrix or the fight against climate change and the digital economy and foreign relations as essential goals. In this sense, there will be efforts on environmental protection and investment in the development of renewable energy technology. The 14th plan seeks to reform natural resource property rights laws to protect rivers, lakes, and forests. To this end, it wants to "implement key projects such as energy system optimisation and energy-saving technology transformation and accelerate the revision of mandatory national standards for energy consumption limits and energy efficiency of products and equipment".

Chapter 39, "Accelerating the green transformation of the development mode", seems fundamental to understanding China's subsequent actions. For the coming years, China is concerned about the water problem and puts it in the middle of the strategies. It will try to reduce water consumption with agricultural efficiency and recycling.

## THE IMPORTANCE OF OIL, FOSSIL FUEL ENERGY, AND THE PETROLEUM-BASED AUTOMOTIVE INDUSTRY TO THE UNITED STATES

The oil trade will decline as renewable energy use progresses. According to the IEA (2019: 7), demand for oil products will fall by between 2.5 million and 4.3 barrels per day [mb/d] in 2030. It represents an average estimated loss of 63 billion US dollars per year at the average price of the past 50 years. Since the United States

is the leading exporter of refined oil and the primary importer of oil globally, the economic activity of refining in that country will be severely affected with an impact on GDP. According to the MIT's OEC, using the 1992 revision of the Harmonized System classification; in 2017, the leading US exports were refined oil (\$74.5 billion), automobiles (\$56 billion), aircraft, helicopters, and spacecraft (\$54 billion), gas turbines (\$31.6 billion) and packaged drugs (\$29.5 billion). Her main imports are automobiles (US\$ 178 billion), crude oil (US\$ 129 billion), broadcasting equipment (US\$ 105 billion), computers (US\$ 73.5 billion), and vehicle parts (US\$ 67.1 billion). China is the leading export trading partner for the United States, after Canada and Mexico, while the reverse is that the US was the first export trading partner for China in 2020, followed by Hong Kong and Japan. The United States was the fifth supplier of Chinese imports, while the Asian country was the primary source of US imports, followed by Mexico and Canada.

The American auto industry is fuel oil-based, with no significant prospects for conversion to renewable energy. Given its export strength in these and other vehicles related to dirty energy, the slow transformation to renewable energy could severely affect the economy. It is possible that in the absence of renewable energy car production, they will import them, with an adverse impact on the manufacturers of fossil fuel cars. This new car trade will increasingly impact the United States and Mexican economies, where such vehicles are made for North American consumption.

Ford announced in 2018 that it would invest 11 billion dollars in the development of electric vehicles between that year and 2022 (Carey and White, 2018). General Motors announced 7 billion dollars by 2023 (Lienert, 2019). Fiat Chrysler announced a \$2 billion investment principally in Tesla (Coppola, 2020).

The American automotive industry must compete with these amounts of investment in new electric technologies with Chinese companies, which have been manufacturing electric cars since 2009 and already have the most substantial volume of electric vehicles in the world (2.3 million at the beginning of 2019 out of a total of 5 million in the world). However, Norway has the largest share of electric cars in the market, 47%, according to the IEA (2019). The growth rate of electric vehicles in China is unparalleled globally. Its sales tripled from 2011 to 2013, increasing by a factor of 15 between 2013 and 2015 while doubling between 2015 and 2017 and between 2017 and 2018. No other country in the world has such an exponential curve. The United States has accumulated 1 million vehicles and is the second-largest consumer of electric and hybrid cars globally, keeping a much lower growth rate than China's. Nevertheless, according to the IEA, the US has stagnated in its pollution indexes, from oil and carbon, in the 2010-2018 period while China's are growing.

## CHINA'S DOLLAR DIPLOMACY AND TRADE IN LATIN AMERICA

In 2011, Beijing was 23 places behind Washington in many diplomatic representations. By 2016, it was only eight places behind, in third place behind the

United States and France. In 2017, it moved up to the second place, overtaking France, before moving to first place in 2019. Beijing opened five new embassies over those two years: Burkina Faso, the Dominican Republic, El Salvador, the Gambia, and Sao Tome and Principe. This list of countries is not random (Bley, 2019). China seems to be applying what is known as “dollar diplomacy.”

President Taft defined dollar diplomacy in his final speech to the presidency in January 1912. “*It appeals alike to idealistic humanitarian sentiments, to the dictates of sound policy and strategy, and legitimate commercial aims. It is an effort frankly directed to the increase of American trade upon the axiomatic principle that the government of the United States shall extend all proper support to every legitimate and beneficial American enterprise abroad*” (<https://www.britannica.com/event/Dollar-DiplomacyTaft,1912>). Similar to the reorganisation of the diplomatic corps in 1909 to bring foreign policy up to the new role of the United States as a world power after the Spanish-American War, the Chinese government has strengthened its foreign policy, creating embassies and consular offices in the first two decades of the XXI century and floods the world with financial assistance.

Howe (1916) says, “Dollar diplomacy is the name by which expansion abroad and financial imperialism have become known in the United States. [...] He signed the treaty on relations with the states of Central and South America to promote American trade and finance with the active support of the state department and the diplomatic service. Nevertheless, dollar diplomacy is only incidentally a trade policy. It is primarily a financial policy.”

According to Jing Men (2009), the reformulation of the official Chinese ideology led by Deng Xiaoping changed China’s opening to the outside world. After the Tiananmen Square incident in 1989, Deng wanted to begin business abroad even more:

1. He confirmed the policy of economic reforms, advancing the percentage of private property in the economy, which resulted in visible improvements in the population’s standard of living.
2. He emphasised patriotism.
3. He revived interest in traditional Chinese culture, which Mao had disdained, and turned it into a force for integration and social cohesion.
4. Claiming to be the guardian of national pride, the CCP sought a new basis for its domestic legitimacy in recovering the past and its culture.

In this process, the country’s position in the international community was made more accessible by interactions with the outside world giving it an additional reason to converge with the dominant global system. These sets of transformations led to leapfrogging changes in foreign policy, with higher degrees of openness and flexibility. During this period, the long-term goal was to create a friendly and peaceful international environment for China to achieve its internal targets. As part of that, since 1978, tens of thousands of students have been sent to study abroad (Zagoria, 1984).

In institutional terms, Deng Xiaoping came out of international isolation after

the Tiananmen Square incident. For this, he designed a 28-character foreign policy of which “keeping a low profile and tying up his time” (Tao Guang Yang Hui) became very popular. By the early 1990s, Deng had already outlined three tasks for China in the next decade: 1) opposing hegemonism and preserving world peace; 2) working toward China’s unification with Taiwan, and 3) intensifying the drive for China’s modernisation (Teshu Singh, 2014). These embody Asia, Africa, Latin America, Europe, the United States, and multilateral institutions.

The world view was embodied in the 1999 *Going Global* policy. The report says that the *Going Global* strategy emerged in 1999, with the idea of offering a farewell to the self-sufficiency mentality of the Mao era and urging Chinese companies to take advantage of the boom in world trade to invest in global markets. It frames China’s ambitions for worldwide leadership and cooperation as both an ideological and economic starting point. China’s accession to the WTO in 2001 was an essential part of this process. Since then, *Going Global* has evolved from the notion of an investment-driven economy to an innovation-driven economy and reinforced the Chinese Communist Party’s claims to legitimacy by becoming an active global player. *Going Global 1.0* had the first push since 2000, it had a second push from 2012 onwards, after reviewing the flaws observed in the first decade (China Policy, 2017). The US perception in 2021 is that “ it is the only competitor capable of combining its economic, diplomatic, military, and technological power to mount a sustained challenge to a stable and open international system”(White House, 2021).

The second impulse, called *Going Global 2.0*, reflected the desire for global leadership. It is offered as a channel to boost internal economic restructuring and demand from non-OECD countries. Industry plans, such as Made in China 2025, or five-year plans, point to a new economy emerging from science and technology, innovation, services, and consumption. In this area, the 12th Development Plan of 2011 leaps towards renewable technologies, further reinforced in the 13th Development Plan (China Policy, 2017).

All this took on new institutional dynamics during Xi Jinping’s government, such as the Sino African Forum [1], the Sino CELAC Forum [2], the Shanghai Cooperation Organization [3], and positions such as joining the World Trade Organization [4] and taking a more prominent role in the International Monetary Fund (Wang, 2017) and the Davos Forum (Bradsher, 2020). At the same time, it created the Silk Road Initiative, which contains maritime and land routes aimed at developing infrastructure in the world, particularly in countries with investment deficits (Müller-Markus, 2016). It links China with the countries of Europe by land and sea.

The establishment of rail routes with fast freight trains between China and Europe led in the first half of 2017 to an increase in the value of goods travelling by Chinese train by 144% compared to a year earlier. Since then, the freight train has served 35 cities in China, with 34 destinations in Europe reducing delivery time from 36 days to 16 days. The last stop in the West in London. The most eastern starting point in China is Yiwu, south of Shanghai, with a stretch of 12,000 km.

China also promoted the creation of the Bank of the BRICS in 2014 and created in 2014 the first Asian multilateral bank of infrastructure: By the end of 2020, the Asian Infrastructure Investment Bank had 103 approved Members, with 79 percent of the world population and 65 percent of total GDP. Jinping followed Deng since March 2013, who consolidated a leading country's foreign policy, as Taft did in 1909. Chinese trade and investment diplomacy is their way of presenting themselves as a powerful country globally. As a result, in a decade of China's dollar diplomacy, the Yuan's weight in international trade finance rose from 0.45% in 2010 to 2.15% in 2017 and 2.42% in January 2021 (SWIFT Reminbi Tracker, 2021).

*Going Global 2.0* was the initiative of China with Latin America embodied in the letter signed with CELAC after the first ministerial meeting of the CELAC-China Forum in Beijing on January 8-9, 2015, when they agreed to adopt the themes of Energy and Natural Resources. It refers to strengthening cooperation between the region and China in energy matters. It includes "research and technological development and the sustainable use of natural resources; based on equality, integral reciprocity and mutual benefit, in strict compliance with applicable laws, regulations and best international practices, respecting full sovereignty over their natural resources." Likewise, it aims at investment in electricity generation from "water resources, biomass and solar, geothermal and wind energy" [5].

China's total investment in Latin America and the Caribbean between 2000-2018 amounts to US\$ 121,698 million in 402 transactions with an average size of US\$ 302 million (Dussel Peters, 2019). China's entry into Latin America should be understood with this policy and investment framework, with renewable energy and, above all, its leadership in the face of an apparent vacuum in other countries.

The *Going Global 3.0* was the arrival of Chinese private enterprises as they directly invested in foreign markets, set up factories overseas, employing local labour, and acquired foreign companies and infrastructure. The two leading examples are the purchase of IBM by Lenovo and Volvo by Geely. According to CLAES (2019), "As with investments, most (75%) of public bank loans from the PRC to LAC have gone to the energy sector (US\$ 105.8 billion) since 2005". According to The Dialogue, China has lent more than US\$141 billion to Latin American and Caribbean (LAC) countries and state enterprises in that period. In other words, China is concentrated in the renewable energy sector in Latin American countries, starting with Hydropower in Brazil and moving on to solar energy sources in other countries. At the same time, it does not neglect minor investments in oil and gas. In this stage, BYD opened a bus factory in Sao Paulo and started promoting mass urban transport with renewable energy, which has succeeded in various cities.

According to the various definitions of "energy transition," changes in the energy and economic system over the rest of this century will be characterised by a shift from almost total dependence on fossil fuels to a much higher reliance on renewable energies (Griffiths, 2019). China's policy focuses on being a leader in renewable energy and massifying it globally. Latin America is an important starting point because it is a US oil-importing trade zone with many oil-exporting countries. Affecting the US oil trade in Latin America affects US-Latin American relations. It is the top US

export product and, in many cases, the main product imported from the US, particularly in the Caribbean Basin. The next source of US trade with Latin America is automobiles and gasoline-powered vehicles. With the change in the energy matrix led by China, these trade relations will change and, with them, the political ties.

According to Woodward et al. (2020), the global EV forecast is for a compound annual growth rate of 29 per cent achieved over the next ten years: Total EV sales growing from 2.5 million in 2020 to 11.2 million in 2025, then reaching 31.1 million by 2030. In 2018, the global electric car fleet exceeded 5.1 million, an increase of 2 million from the previous year, and almost doubled the number of new car sales. The People's Republic of China remains the largest electric car market globally, followed by Europe and the United States. Woodward et al. (2020) expect that by 2030 China will hold 49 per cent of the global EV market, Europe will account for 27 per cent, and the United States will have 14 per cent. Norway is the world leader in terms of electric cars market share. According to Woodward et al. (2020), total EV sales will grow from 2.5 million in 2020 to 11.2 million in 2025, reaching 31.1 million by 2030. This consumption pattern of electric vehicles changes the flow of automotive trade, as there are countries that do not manufacture these vehicles in significant quantities and modifies the oil trade. Chinese electric car manufacturing dynamics exceed the German, Japanese, and American dynamics. The consumption of electric and hybrid cars in China was triple that of the United States in 2018, and in 2010 they started in more or less the same place with 1,430 vehicles and 1,190, respectively. Griffiths argues (2019) that as these challenges and opportunities evolve, managing international relations through diplomacy will become an increasingly important instrument of oil country foreign policy as countries strive to position themselves in the future energy landscape strategically. He adds that while various forms of multilateral diplomacy are essential to simultaneously align the energy transition interests of multiple actors, bilateral diplomacy is the most direct means of pursuing national interests (Griffiths, 2019). The change in the energy matrix is essential for middle eastern oil exporters, the United States, and the oil-producing countries of Latin America.

The outlook is that in twenty years, by 2040, 55% of new car sales and 33% of light vehicles on the road could be electric, saving 7.3 million barrels of oil per day (mb/d) of transport fuel and an additional 2,000 TWh of electricity demand. The demand for oil for petrochemical production will exceed the demand for oil for transport, according to the IEA (2019). However, according to its sales growth statistics for 2013-2018, they will arrive before that date. Evidence shows, however, that China consumes more coal in energy generation to input EVs with more CO<sub>2</sub> pollution.

## SOLAR PANELS IN LATIN AMERICA AND THEIR IMPLICATIONS

The increase in solar energy in China is remarkable. Following the Chinese government's decision to change the energy matrix, due to the findings of the report

Energy Futures and Urban Air Pollution: Challenges for China and the United States (2008), renewable energies have shown high growth rates. In this section, we revise solar energy for electricity generation. As shown, solar energy use growth is 33 percent from 2010 onwards. It makes China the country with the largest installed capacity in the world. It has 44.3% of PV electricity generation (IEA/PVPS, 2019). It is four times more than in the USA and the European Union.

In the same way, the expansion of the manufacture of Chinese solar panels has been a success as it has the largest share of the global supply. China is the world's leading exporter of solar panels, cheaper by about \$42 than American ones of the same range. This price difference led to US tariffs on Chinese solar panels since 2012 and later in the trade war. In March 2017, the US renewed them for a further 18 months. On the European Union side, in 2013, Chinese panel manufacturers were accused of artificially lowering prices and dumping. The European Commission withdrew the measures in September 2018 after considering that the market situation had not changed and rejected the investigation requested by European solar panel companies.

As far as Latin America is concerned, imports of Chinese solar panels increased to such an extent that they exceeded imports of US panels. From 2013 onwards, the trend is upwards because of the first solar park project in the region. After this, the construction of solar parks in Latin America grew. Thus, throughout the region, installed capacity has grown by an average of 100% per year since 2015. The countries with the highest growth are Chile, Mexico, and Brazil.

Chile has solar parks with Spanish, Japanese, and Chinese technologies. For the time being, it only has one project financed by China. In 2013, Sky Solar built the first solar park with Chinese investment in Arica, Chile, a company dedicated to solar energy (*PV magazine*, 2013). The same company, in 2018, bought the Silva Solar photovoltaic park for 150,000 dollars from a Chilean company (Sánchez Molina, 2018). Besides, ET Solar opened in 2013 a sales office in Santiago for local companies interested in solar energy (*PV magazine*, 2013). The same year Jinko Solar supplied solar panels to a solar park in Coquimbo (*PV magazine*, 2013). Similarly, Yingli Solar, in 2014, opened an office in Santiago to increase the supply of Chinese panels in Chile (*PV magazine*, 2014).

Brazil has the most significant relationship with China in Latin America regarding photovoltaic energy. In 2014, Yingli Solar opened an office in Brazil to sell solar panels to different solar farm projects. Three years later, the Chinese company BYD started operations of the solar panel factory in Sao Paulo with 49 million dollars (*PV magazine*, 2015). This company already had an electric bus plant in Campinas in 2016.

In 2018, the Chinese company Hanergy started operations of a BIPV (Building Integrated Photovoltaic) technology construction, a six-storey building with state-of-the-art light panels for offices of Chinese companies, the first of its kind in Latin America (Xinhua, 2019). The same company announced cooperation contracts for 4.3 million dollars with 15 companies to implement its technology in Latin America (Bellini, 2018). Likewise, there is a new light panel factory with an invest-

ment of US\$1 billion (Bellini, 2018). Besides, the manufacturer of solar panels, Jinko Solar, has signed an agreement with Aldo Solar for electricity generation and distribution in Brazil (Sánchez Molina, 2020).

For its part, Mexico received support from the IDB to build solar parks with Spanish technology. However, Yingli Solar has an office in Mexico City to market its solar panels. The French group Neoen is constructing the El Llano solar park in Aguascalientes with the expertise of Sinohydro, together with the Spanish company Prodiel (Sánchez Molina, 2019). In Argentina, two of the 16 solar plants are Chinese investments: the Iglesia-Estancia Guañizuil solar park, which uses technology from the Chinese company Jinko. Secondly, the Cauchari solar park in Jujuy, the largest solar park in Latin America, is 85% financed by the Export-Import Bank of China. These two solar parks generate the most electricity. Of the other Argentinean solar parks, two in San Luis Province use BYD panels. On the Bolivian side, the solar park Oruro, built by the Spanish company TSK, uses Chinese solar panels of the brand Jinko Solar and is financed by the French cooperation, the European Union, and the Bolivian government. Likewise, in 2019 an autonomous parking lot with the technology of the same Jinko Solar was inaugurated in the Bolivian Private University (Sánchez Molina, 2019).

The relationship does not stop at the marketing of solar panels. In Colombia, the Chinese government donated 3,000 panels valued at \$1.5 million to rural communities. The Minister of Energy in Colombia thanked the Chinese government for the donation and informed the press that Chinese companies are interested in entering the country's bidding process for renewable energy (Sánchez Molina, 2019).

In terms of solar energy, the Chinese presence in Latin America is considerable. Brazil is an important market for manufacturing and marketing solar panels for China. Recently, Chile and Argentina have shown interest in constructing solar panels in the area to extract lithium in the mines near the solar projects. Without a doubt, the purpose of marketing solar panels throughout Latin America is to build solar parks to use energy in other Chinese projects.

## HYDROPOWER AND ELECTRICITY DISTRIBUTION SYSTEMS IN LATIN AMERICA: A STRATEGY OF PENETRATION?

China's penetration in Hydropower is remarkable for all of Latin America, hand in hand with the continuous expansion of Chinese companies around the world. The control of renewable energy in Latin America can be a plus in China's quest for hegemony in the region. It is also a direct attack on the continued use and promotion of fossil energy as a source of electricity by the United States.

In 2017, the president of Brazil, Michel Temer, met with Xi Jinping to sign 14 international agreements. The most important were those related to the construction of the transmission line of the Belo Monte hydroelectric plant (the second largest in the country) in Northern Brazil, the agreement between Brazil's National Bank for Economic and Social Development (BNDES) with China's Export

and Credit Insurance Corporation, and the signing of a memorandum by China National Nuclear Corp to continue work on Angra 3 (Portal Planalto, 2017).

Since then, in 2019, the State Grid Corporation, a Chinese electricity distributor, has bought 55% of CPFL in Brazil. State Grid itself mentioned that it would make a total investment of \$38 billion over Five-years. In addition to Hydropower, they will use wind and solar energy. On the other hand, in 2016, Three Gorges acquired the properties of DUKE Energy in Brazil, an American hydroelectric company. The buyer “is a renewable energy group focused on developing and operating large-scale hydropower” (Spring, 2018). CTG is also engaged in renewable energy businesses, including wind and solar power. Present in 40 countries, CTG is the world’s largest Hydropower producer with an installed capacity of about 100 gigawatts, both in operation and under construction[6].

In Peru, Yangtze Power International bought 86.3% of Sempra Energy; the same American company operated through Luz del Sur (Rojas, 2019). In Chile, State Grid bought Sempra Energy’s stake in Chilanquita Energy (the country’s third-largest electricity generator) and other local Chilean businesses for \$2.23 billion, winning the transaction from Italy’s Enel and Canada’s Brookfield (Nogales Toledo, 2019).

In Bolivia, on the other hand, the relationship with China has been fruitful in various fields. In hydroelectric energy, the Chinese company Sinohydro will carry out the Ivirizu project, two hydroelectric plants on the Ivirizu River that will generate 279.9 MW and produces 69 MW (LaRazón.com, 2019). Both plants represent 10% of the total demand in Bolivia.

However, in terms of construction contracts, Ecuador is the country that signed the most contracts with Chinese companies in Latin America for the construction of hydroelectric dams. The companies contacted were: Sinohydro, Gezhouba, China National Electric Engineering Company, CWE, Hydrochina, and Harbin Electric. There are seven hydroelectric plants in the country with a Chinese presence in construction or financial assistance. In total, 4,872 million dollars were used, financed by the China Development Bank and the China Export Bank. The Export Bank of Russia financed one of the hydropower plants with 240 million dollars.

The largest hydropower plant is Coca Coda Sinclair, built by Sinohydro and financed by the Export Bank of China with \$2.9 billion. It generates 1500 megawatts and represents 35% of the country’s electricity. It was inaugurated in 2016 by Ecuadorian President Rafael Correa, together with China’s President Xi Jinping. With this visit, both heads of state reached a strategic partnership agreement Ecuador-China. The Joint Declaration between the Republic of Ecuador and the People’s Republic of China on the Comprehensive Strategic Partnership Partnership points 5 and 9 grinds on the following principles. “[They]will strengthen cooperation in productive capacity and investments and implement important cooperation projects in the areas of hydrocarbons, mining, infrastructure, hydraulic works, communications, and finance [...] the strengthening of coordination and cooperation in the multilateral sphere is a sign of the high level of strategic mutual trust” [7].

China’s plans to hamper the US promoted fossil-fuel electricity generation. The

purchase of assets, hydroelectric plants' construction, and the expansion of solar panels is a direct blow to fossil energy. Thus, the increase in infrastructure loans is an essential pillar for winning diplomatic relations in Latin America. According to Bolivia (with Evo Morales), Brazil, and Ecuador, the relationship with China will bring development to the region. The Asian country is more important for Brazil and Ecuador than the USA because of the significant investments.

## CONCLUSIONS

China has a robust environmental policy and is leading the change of the global energy matrix from fossil fuel to renewable energy, following the UN's Climate Change Agreements' dictates carefully. It has included this item in several of its Five-year Development Plans and the financing of international energy projects. The result sought in the 2010-2020 periods is less coal consumption, less petroleum for energy generation, the development of electric cars technology, and cheap production of solar panels. These prices have fallen 85% over the past ten-year period making them readily available worldwide. The US attacked China for dumping, so did the EU, but eventually, the EU withdrew its case from the WTO court. The US has kept and raised its tariffs on solar panels with the trade war while shutting down the WTO court.

China has not reduced coal consumption and pollution as it has substituted oil-based thermoelectric plants for coal-based ones. Increased electricity use has led to increased imports of coal and more pollution while coal ones replaced oil-based thermoelectric plants.

For the United States, the importance of both the oil and the auto industry is a matter of national security as fossil fuel is the main export of the United States. The automotive industry holds the economy together. The trade relationship with Latin America and Europe is centred partially on the supply of refined oil. A complement of this is the automotive industry firmly based on fossil fuel. There is evidence that it is lagging in innovation towards renewable energy vehicles and all projections show it lagging continuously. The problem is that as renewable energy vehicles have entered the market and are non-US made, they will replace American-made cars affecting both the Mexican and Canadian economies articulated with the American automotive industry.

The shift in energy use will impact oil-exporting countries in the Middle East, Latin America, and the US, reducing export income. At the same time, there is an increase in imported new renewable energy technology. The impact will reflect slower growth for those countries and a new impulse on countries adapted to renewable energy.

China has developed a Dollar Diplomacy and prefers giving loans and financing development projects to a more substantial political and military presence. In general, Trade and Latin America, in particular, has boomed. Mexico and Central American countries that seemed impossible to engage with far eastern partners are

now importing from China and Asia, replacing their historically linked markets in Europe and the United States. Caribbean Basin countries have an export market concentration in the US but are shifting on the suppliers' side.

The introduction of renewable energy technology in Latin America has been through electric vehicles and solar panels. There is now a massive electric bus fleet distributed among main capitals and big cities from Mexico to Argentina as a way forward to cleaner air in highly polluted cities like Mexico City, Medellin, Guayaquil, Santiago, Buenos Aires, Sao Paulo, and others less polluted like Montevideo, San Jose de Costa Rica and Havana. Simultaneously, there is an introduction of private use electric vehicles sold in some countries and in the process of being manufactured in others. The possibility of electric car manufacturing in Mexico and Colombia simultaneously as electric cars and SUVs sold in several Latin American countries will inject at least a new view of how these might change the total stock of cars and other vehicles. As these grow, the oil bill of those countries drops, and the need for more electricity generation and distribution grows. There is some evidence of European competition and the surge of one Mexican firm in this branch of industry, but little on the American side. Tesla leads the US electric car industry with limited production and few vehicles exported to Europe and China, followed by Rivian, but little else. Tesla instead wants to enter the Chinese market and produce there for local consumption, given the effects of the trade war.

The use of solar panels in Latin America and their implications for electric power generation is growing fast from Mexico to Argentina, Europe, and Asia. Less so in the States. China has invested or lent money to install large solar parks and sells its solar panels at increasingly reduced prices, followed closely by Germany. At the same time, there is little evidence of an American solar panel industry booming. Instead, it imports solar panels from China with 60% tariffs and from Italy, Germany, Spain, other European countries, and Mexico. A limited but dynamic solar panel industry in the US might eventually compete with these others. Tariff protection has that aim. As these become universal, oil demand for thermos-energy will drop. It has already fallen in China as it substitutes thermos energy for renewable energy. While reducing carbon consumption, she has stopped the growth of imported oil consumption.

There is evidence of a growing transfer of Hydropower and electricity distribution systems in Latin America towards Chinese firms. The substitution from other foreign firms might shift towards increased Chinese energy technology. The inference is that Chinese firms might have a penetration strategy similar to that of US firms after WWII, buying out British firms.

The conclusion is that the shift in the energy matrix will change the world economic and political power structure and the relationships built on the global oil trade throughout the XXth century. There is a significant replacement of oil-based equipment with new renewable energy generation equipment that will help relaunch the global economy led by China and the Asian countries. In contrast, competition from Western countries will slowly grow. The entire transport fleet will change in the foreseeable future. Cars, trucks, ships, aircraft will be either electric or hybrid

with Chinese technology and replace the existing oil fuel-based equipment with the inevitable trade flow consequences. US industry is lagging, and she seems to make a high gamble on the continuation of fossil fuels, with some innovation for cleaner air that will compete with these. The consequence is that the ties between the Latin American countries and the US will change.

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