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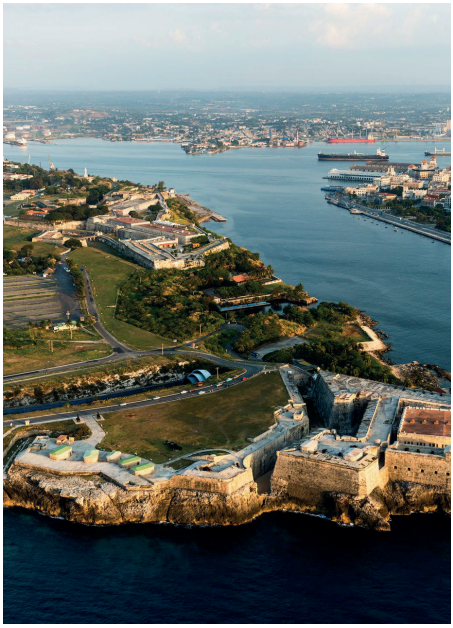
# INFRASTRUCTURE

B1 Water supply replacement with MDPE pipe

B2 SNET pilar (antenna) as part of domestic intranet



B3 Havana Bay Tunnel east portal

B4

# INFRASTRUCTURE
## OVERVIEW

Infrastructure in Cuba acts as a visual representation of the island's tumultuous history. Characterized in the first half of the twentieth century by a range of successful engineering projects such as the 1958 Havana Bay Tunnel [B3], the ensuing half century of trade embargo amounting to a near blockade imposed by the US—its nearest and economically most powerful neighbor—as a sanction against socialist government rapidly curbed the island's access to materials and resources. It was therefore in many cases deprived of the capacity to maintain and modernize infrastructure. Given Cuba's inherently remote location as an island nation, its infrastructure adopted a similar penchant for improvization, local innovation, and ad-hoc functionality. As a general rule, the government prioritizes tourism as a catalyzing industry to spur further development. Resultingly, many infrastructural improvement projects, such as water distribution piping replacement [B1], have benefitted resort districts first to make the island more desirable for visitors, who in turn are expected to support the local economy through their consumer expenditures. Capital is then made available to fund further projects that benefit the general populace. The transparency of this approach, cited in more than a few writings on the topic, of course should be taken with a grain of salt depending on the specific actors and multinational agencies involved in the dealmaking. This chapter will take a brief look at Cuban „infrastructures" in the traditional sense of the word (underlying support systems that allow society to function) through the lens of four topics: water and sanitation, communications, transportation, and energy. These systems each have their own range of successes and failures. Within all of them, however, a common willpower is evident amongst the Cuban people to be self-reliant in the absence of better solutions. Although the strong and centralized socialist government could be criticized for withholding certain technologies or amenities from its population, it also had very few alternatives in the face of geographic isolation and trade deprivation. In perhaps even a somewhat perverse way, the issue of frequently inadequate provisions by the government forced the Cuban people to depend on eachother and a welfare state, which aided in the building of a meaningful social infrastructure. An underground neighborhood intranet haphazardly strung between residents and a series of satellite nodes [B2], although crude, brought much of the urban population online well before the state telecommunications agency offered official connection options across its more formalized (and heavily monitored) network. Similarly, semi-regular power outages in the overburdened and undermaintained supply grid [B4].

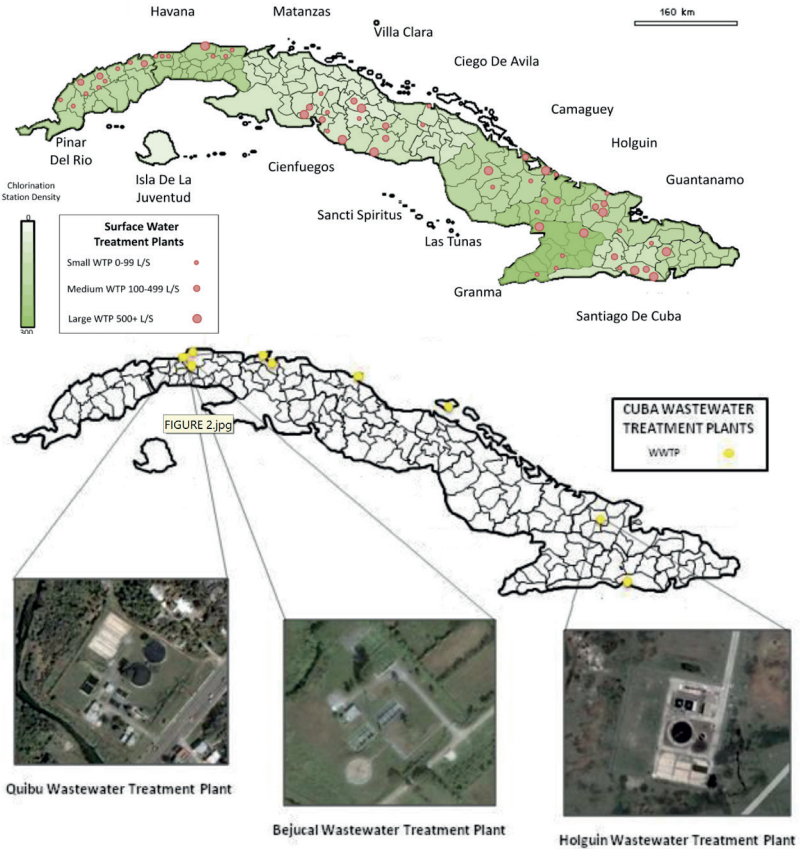

B5 Drinking water is sometimes supplied by truck

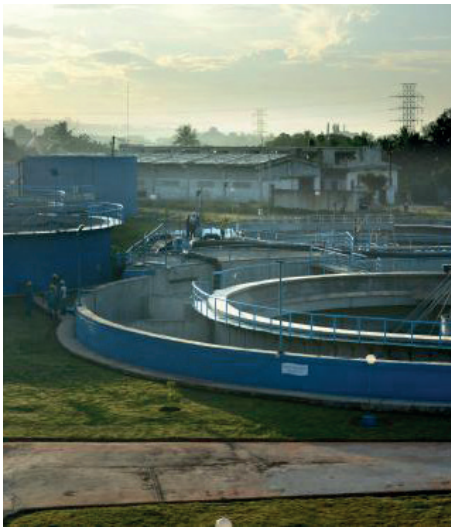
B6 Turn-of-the 20th century water infrastructure

B7 Sewage outflows discharge directly to the sea in some cases

—although not as frequent as during the early 1990s when Cuba was suddenly deprived of Soviet oil [1]—have perhaps catalyzed more sustainable consumption habits and mindful energy use. Although Cuba was at one time a Latin American success story of potable water availability as well as sanitation and wastewater treatment, this has not been the case in recent years. Early twentieth-century water engineering marvels, such as the Acueducto de Albear [B6] completed in 1897 to supply upland spring water to Havana, largely remain trapped in their time and have either fallen into states of disrepair or severe capacity mismatch in relation to a growing population. In particular, the *Sistema Central* sewage network of Havana—at over 1000km the most extensive in Cuba—is recently facing severe challenges; originally designed to service 600,000, it is currently utilized by closer to 1 million [2]. Most of Cuba‘s water management is orchestrated by a central agency: *Instituto Nacional de Recursos Hidraulicos*, although some degree of semi-privatization has very recently begun in certain localities [3]. In numbers, Cuba‘s water and sanitary infrastructure looks good: 90-95%

of Cubans have access to drinking water (when it is available) and up to 98% of wastewater is collected [4]. Reality, however, tells different story. Surface and groundwater, although generally of acceptable quality and with enough treatment plant capacity to supply the population, is only able to be delivered for a few hours each day in some localities [5]. And although wastewater is generally collected at high rates, as little as 4% in 2007 [5] is regularly treated before being discharged, often directly to the sea [B5] or into the watershed if it is not already leaked prematurely from an undermaintained sewage main [6]. The issue with drinking water specifically is not its potability, which is generally measured to be quite acceptable if only marginally; rather, it is the decaying infrastructural network of pipes that traverse the island to transport it [w4]. In urban





B9 Settling tanks at a new wastewater treatment plant

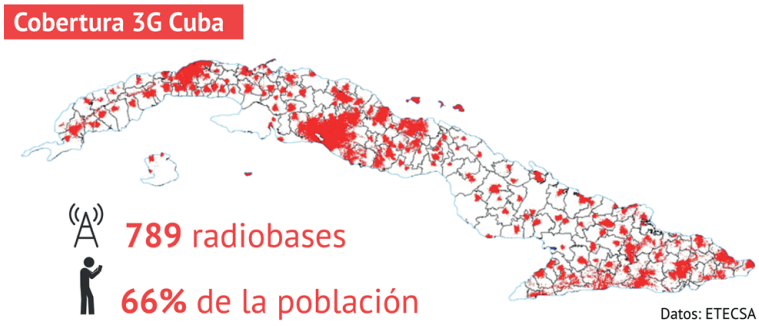
areas and Havana especially, many residents simply cannot depend on municipal water supply to be available on-demand. On some occasions, it is delivered to neighborhoods via potable water trucks [B5], from which local residents fill their cisterns for storage until receiving the next installment [3]. Areas generally challenged least with drinking water availability are those built up with hotels and resorts, where tourist comfort is prioritized [8]. In 2019, the New Constitution of Cuba cites a right to water in Article 76, allocating a new obligation for the government to improve water distribution across the island [7]. The proper functionality of wastewater infrastructure on the island is perhaps even more problematic. Less than half of the island‘s population is integrated into a wastewater collection network, particularly in rural areas [5]. As previously mentioned, only a marginal amount of collected wastewater is actually treated before discharge. Most treatment occurs in 302 lagoons, of which in 2010 only 53 were labeled as „efficient“ by the INRH. At least eleven proper wastewater treatment plants (WWTPs) have been identified on the island, but only a handful of them were also deemed „efficient“ [5]. However, recent support efforts by transnational agencies ranging from OPEC and the Kuwait Fund for Arab Economic Development to the UN Development Program have made funds available for the construction of new WWTPs, like Luyanó IV in Havana [B8], and improvement of the distribution piping, particularly in urban areas where population growth imposes the greatest burden on sanitation networks or where current treatment inefficiencies threaten drinking water aquifers [5]. After a 2017 constrituional decree for proper management of wastewater discharge, the stage is set to take advantage of innovative water and wastewater treatment infrastructures, including seawater flushing [8], as well as tying WWTPs to renewable energy to reduce demand on the national grid [9].


B10 Until 2018, WiFi was only available at public prepaid hotspots


B11 An undersea cable to Venezuela supplies much of Cuba's internet

Before internet connectivity became a standard feature for most contemporary societies, Cuba was leading Latin America in terms of online traffic. Email was possible fairly early on in the 1990s, and the island established its first cable connection to the US mainland in 1996. But, like many other aspects of Cuban infrastructure, further development was subsequently hampered by the difficulties of expanding under strict embargo conditions [10] and the island today remains one of the least wired regions in the Western Hemisphere [11]. Exacerbated by governmental skepticism that information freedom leads to widespread dissent, the vast majority of Cubans were left in the dark until 2008, when ownership of private PCs became legal [12]. This then catalyzed a rapid trend of „opening up" network connectivity. In 2020, technological advancement on the island appears to be developing at such a rate that many sources and coverage maps are outdated within months. For instance, only maps of 3G coverage [B12] could be located despite recent reports of limited 4G being rolled out in urban areas (and already being exceeded by over 100% in anticipated demand [13]). Broadband access is largely made available via an undersea cable to Venezuela, financed by China, in 2011

[B11]. The US Navy also maintains a secure fiber optic link between Florida and Guantánamo Bay [14]. By 2015, the state-run internet and telecommunications monopoly, *Empresa de Telecomunicaciones de Cuba S.A.* (ETECSA), introduced prepaid public WiFi hotspots (sponsored by Huawei [14]) in cities [B10, B13], although the access cost per single hour can approach almost 5% of a standard monthly salary and connection speeds are severely challenged due to a limited amount of connection points relative to the population. This has led to innovative workarounds of packaging expensive web data into standard SMS installments. In 2019, registered internet access in private homes was also legalized, although connections remain cost-prohibitive and content-limited by moderate censorship and surveillance [15]. This isn‘t to say




B12 3G mobile data coverage as of 2018 (4G now available in some areas)

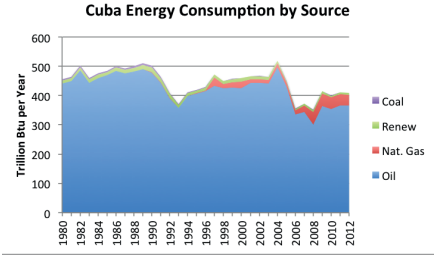

B13 Public internet connection points

B14 Internet and phone cables strung between homes constitute a large part of SNET

that the Cubans weren‘t without meaningful connectivity before the *Ministerio de Comunicaciones* (Mincom) legalizations. Since 2009, the Havana Street Network (SNET) offered domestic uncommercialized LAN intranet. Cables thread between homes [B14] and eventually link up to a handful of principal *pilares* [B2]. While Mincom was aware of its existence, SNET users followed a policy of no pornography, no politics to avoid trouble. Where SNET isn‘t available—that is, most areas that aren‘t Havana—*paquetes seminales* offer weekly packages of the outside world for as many as 3 million users. Up to a terabyte of content is centrally downloaded onto external harddisks (possibly siphoned from faster tourist resort internet connections) which are then switfly transported across the island [15]. Although Mincom continues to increase house household internet access, its continued practice of surveillance and its gradual absorbtion/centralization of informal networks (e.g. SNET) continue to threaten open-source content sharing. Incremental infrastructures and paquetes offered an alternative, self-policed method of connecting users more rapidly than centralized web infrastructure [14, 16]. Although internet and mobile data are available to those who can afford it or at least to those who are crafty, Cuba‘s population suffers from a general lack of technological literacy and availability. SIM penetration has only reached 51% despite broad 2G and 3G coverage since 2018 [17]. ETECSA increasingly looks abroad for friendly corporations to assist. Such agreements could set the stage for further network enhancements on behalf of big tech, e.g. Google [18] and Airbnb. The question remains how technological advancement can meaningfully take place when web-based information is either actively censored or sponsored by corporate investment projects.

Until 1959 Cubas energy systems used to be some of the most elaborate in Latin America. Due to the following embargoes political isolation and rising gas prices in the 70s, Cuba underwent a fossil energy shortage. As well as being poltically isolated the status as an island nation made Cuba reliant on its poltical allies resulting in difficulties to afford maintainance of existing systems and apply modern technology. Till the 2000s the main aim was to keep systems running and supply enough energy to the evergrowing electricity consumption, while avoiding ever occuring power cuts.

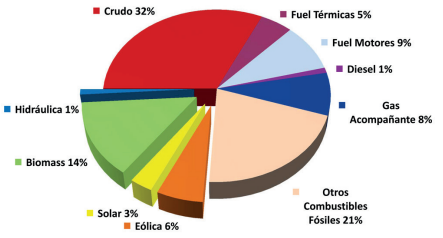
As for a long time Cubas energy mix is primarily based on fossil energy, heavily depending on oil [B15]. Nowdays almost 90% of the Energy is won by Venezuelan petrol. To be less dependent on energy imports Cubas main obejective is to produce at least a third of its needed energy by 2030. Due to its geographical position and resources 24% of the energy shall be generated by renewable energies (B16).




B15 Cuba's energy consumption by source, based on EIA data.

56% of the energy is consumed by private households. Enabling all Cubans access to the national energy network has been a mayor task in Cubans politics. By connecting the last 5% in remote areas, the electrifrication process has been completed in 2019.

While the demand on electric devices is growing, Cuba has to plan how to expand energy production without stressing the use of fossil fuels. Huge investments will have to be made to renovate the 1970s power stations as well as imply renewable energy parks throughout the country. This difficult task is hindered by the reinstalled US-embargo as well as the political and economic crisis in Cubas closest ally Venezuela. Crumbling fuel prices shook the petro-based




| Energy Source | Capacity to be installed (MW) |
|---|---|
| Biomass | 860 |
| Wind | 633 |
| Solar Photovoltaic | 700 |
| Hydropower | 56 |

B16 Energy mix for 2030, Renewable Energy Conference, presented by Cuba's energy ministry in 2015

B17 A vintage car passes by a thermoelectric plant in Santa Cruz del Norte

economy further, causing a huge impact on the Carribean Island. Even a bilateral pact signed in 2000, which allows Cuba to pay for Venezuelan oil imports by offering services to the South American country ranging from doctors to advisers, can not absorb the challenges.

Nevertheless Cuba‘s government is aware of the importance of a stable power supply for the country‘s well-being at financial, political and socio-economic scale. Therfore it has imposed ambitious plans to guarantee the renovation and development of its energy network by 2030.

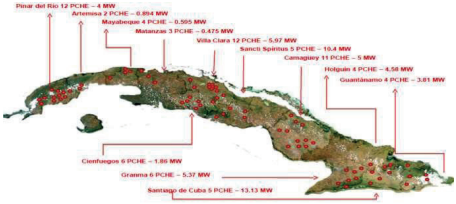
Cuba‘s energy system is not only affected by poltical challenges. Furthermore its geographical position in the windy region of the Carribean makes Cuba susceptible for natural disasters such as hurricanes and earthquakes. These can lead to unplanned power cuts as well as govermentally planned power plant shut downs which leaves the inhabitans without electricity for hours. This can also be the case if the ailing technology breaks down or the government has to impose power cuts due to lack of energy resources.


B18 An ideal energy mix for a green Cuba

Regardless to all difficulties the country strives for a more self-dependent energy mix, applying technology such as off- and onshore wind parks, hydroelectric power plants, solar plants and using farming waste in biomass power stations [B18].

The main importance of Cuba‘s energy revolution regards its people. Fuel shortage has often led to cuts in industrial production and public transport in order to save energy to ensure basic services like hospitals and food distribution. Therefore a new and secure network is needed.

As part of Cuban socio-culture the

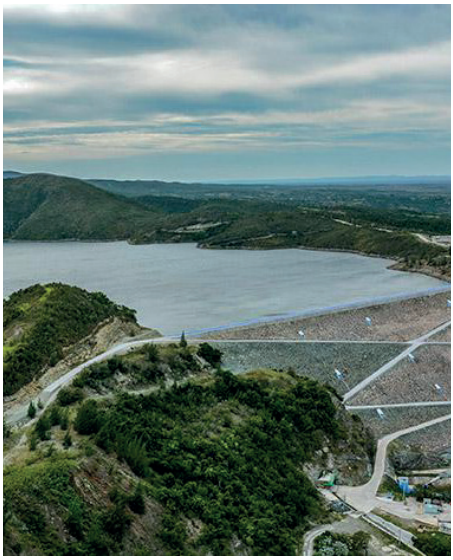



B21 Location of the new hydropower plants to be built in Cuba in the coming years

people are asked to play their own role in reaching the 2030s goals. This includes reducing energy use in summer peaks, with air conditiong being a main source for consumption or the installation of private power plants. Since 2019 setting up private solar panels are subsdisied by the the state [B19]. Excessive energy can also be sold to the state at a fixed rate. Solar photovoltaic capacity already installed represents only 4.2%. 2019 started to be the year of power

B19 Luis Bérriz's power plant on a roof of Havana

B20 Termoeléctrica Carlos Manuel de Céspedes



B22 The Mayarí reservoir

B23 Gibara wind park, in the eastern province of Holguín

plant renovations. Three major plants from 1970 in Mariel and Holguin are going to be refurbished, promising 700 Megawatt after completion [B20].

At the same time 43 solar parks with 179 Megawatt and 2 Windparks [B23] with combined 100 Megawatt are going to be connected to the national energy network. The participation of wind power into the energy balance of the country should be around 6% of the total in 2030. Cuba is also looking for further spots to impose hydroenergetic plants [B21]. At the moment Mayari Reservoir is made accessible for energy production [B22]. Hydroelectricity represents 0.5% of the total electricity produced in 2014, and shall be extended to around 1% by 2030.

The highest amount of renewable energy is already won by Biomass and shall depend 14% on this sector by 2030. It mostly orignates from agricultural crops and their residues, forest residues due to planting and animal waste.

All these renovations will be difficult to achieve without foreign investment and cooperations.

Cuba's transportation system contains of roads, railways, waterways, airports and harbours. Ships and planes secure the mobility to and off the island. Trains, cars, buses, bikes and animal traction provide means to moving along the island. [B25] Cuba's transport policy accords to state governed strategic principles and regulations. Due to past political, economic and social influences Cubans have set up unique measures to enable public mobility.

Since 1959s revolution and the isolation from the US - its former main trading partner - it became difficult to finance the once elaborated transport system. Road and railway maintenance sunk to minimum expenses while import of technical gods such as spare parts was cut almost completely. [B24]

The years of belt-tightening measures were increased by events like the global oil crisis and even the economic support from its socialist allies came

B24 Cubans on infamous now substituted camello bus in early 2000s


B25 Residents of Havana are using diverse methods of transportation, Havana, Cuba, 12th september 2019

to an end with the collapse of the eastern European socialist systems. From 1989 to 1993 Importations of transport equipment fell by 86%, while fuel imports shrunk by 75%. [25] In order to survive the events the government rationed resources like oil, reduced industrial production, implemented scheduled blackouts and minimised finance of public utilities accompanied by economic reforms.

To support the reforms Cuban authorities described a multitude of behavioral and technological solutions. Among those: the promotion of walking, cycling and the use of animal traction; reorganizing its bus systems and subsidize collective taxis. Furthermore unnecessary or unwanted journeys were frowned upon while hitch-hiking and shared use were advertised. [25]

These informations help to understand the current state of the Cuban transportation system, which is slowly recovering from the former embargo.


B26 A taxi driver drives a vintage car in downtown Havana, January 16, 2015.

New cooperations with Russia and China secure investment in ports, trains and buses [26]. Unfortunately the county's modernisation endeavours are hindered by Venezuela's political crisis - Cuba's strongest alley and Oil supplier - as well as recent charges from the US administration, while the Covid-Pandemic amplifies the already existing challenges.

**Roads**

The island's road system founds on the leftovers of 1959, which used to be one of the most efficent highway systems in South Ameirca, with the Carretera Central being its backbone [27]. Nowdays many of the old roads need restoration, including fixing pot holes and resurfacing. Most investment has been spent in a broader network while the existing parts have been neglected.

Cuba's famous stereotype about American vintage cars driving through Havanas streets have their origin in the importation ban in 1960. [B28] In 2011 the Cuban government legalized the purchase and sale of post 1959 cars and since 2020 cars can be brought from government dealers. [28]


B27 main roads cuba

Today there are about 25 cars per 1.000 inhabitants driving on Cuba's roads. [29] The relatively low ratio explains why different means of shared systems have developed on the island. Cars are shared among different drivers, hitch-hiking and collective taxis became common practice and sometimes the number of passengers exceed the limit of car seats. The often old and overused cars run on exchanged motors and maintenance relies on a limited spare part market.

The public transport in cities is covered by a state bus system and private-run shared taxi system. Cuba's rural population depends on public transportation but due to limited vehicle supply sometimes waiting for a ride can take some time. Buses were often donated by partner countries and are going to be replaced by electromotive Chinese Yutong buses.

**Railway System**

Cuba's railway system was once bulit to transport sugar and other gods to the respective harbors in the 1830s. It developed to be the most advanced system in Latin America but due to mentioned maintenance issues nowadays lacks functionality. Over the next years the system is going to be renovated.

New rails shall promote the transportation of production gods as well as offering less expensive and

B28 Cuba's new Chinese-made passenger train leaving Havana

B29 A fisherman walks the streets of Mariel. In the distance, construction is underway on the Port of Mariel, 2014

B30 Cubans leave their country in a makeshift wooden boat during a mass exodus from Mariel, 1994

reliable options for personal travel. New trains from Russia and China shall guarantee adequate vehicles in exchange of the run-down carriages and railroad engines [B28]. 2019 marked a little revolution for public transport, with the maiden voyage of Cubas first new train in over 40 years, with more trains to follow [30].

**Ships**

Most of Cubas import used to be shipped to Havanna harbour. Since 2014 Mariel terminal has been established [B29]. The new deepwater container terminal is supposed to help Cuba's import and export scheme as well as providing a destination for Panama channel trade. [31] Oil, Cubas main energy resource arrives by fuel filled tankers.
The US cruise ship embargo in 2019 is considered to cause some damage in tourism industry as well as ship related works [32].

Once being a proud marine nation in the Caribbean the Cuban government set up stronger rules for boat ownership and marine travel following a mass exodus on boats in the 1980s and 1994 [B30] Although being an island only a few people own the right to board a boat. [33,34]

B31 Two cyclists on the streets of havana

## Alternative Transportation

In both urban and rural areas using bicycles became important in times of fuel shortages. Therefore the older generation often disregards bikes as a sign of the deprivations of the 1980s while in recent years the younger generation rediscovered the bicycle as an favorable addition to transportation. Bikes are being customized and bike taxis are a common sight on Cubas street. [35]

Animal traction is used on Cuba's streets. People and gods are being transported in carriages and offer potential for minimizing carbon dioxide based transportation.

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