THE ROLE OF URBAN RAIL IN A SUSTAINABLE AFRICA

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FOREWORD

The 27th Conference of the Parties (COP27) in Egypt is an opportunity to focus on climate action for Africa, which is seeing faster warming than other continents, even as its carbon emissions are comparatively low. Africa is also transforming dramatically, with a fast-growing population and the world's highest urbanisation rate. By 2050, more than one in ten people worldwide will live in an African city.

A key challenge is to ensure that the growth of African cities meets the UN's Sustainable Development Goal 11: Making cities inclusive, safe, resilient and sustainable. For this to happen African cities must develop more sustainable transport systems, both to reduce carbon emissions and to foster inclusive socio-economic growth.

With COP27's focus on implementation, Alstom commissioned this study from EY Climate Change and Sustainability Services to highlight the benefits that increased investment in urban public transport can bring to Africa's cities and support their sustainable growth. The study shows the potential carbon emission savings from increased rail transport, as well as other economic and social benefits such as increased employment and health outcomes.

Increasing the modal share of rail transport will bring better access to socio-economic opportunities, reduced congestion, increased safety and improved air quality on top of decarbonisation. This will require substantial public and private sector investment to create sufficient and convenient public transport for residents coupled with the implementation of policies to incentivise this transition. Therefore, the paper concludes with concrete recommendations on how this vision can be achieved and why there should be a sense of urgency. According to the IEA, the modal share of rail must grow by more than 40% by 2030 to achieve Net Zero in transport sector by 2050. This means we not only need more trains, but we need them now.

ANDREW DELEONE,
President of Alstom Africa,
Middle East and Central Asia

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EXECUTIVE SUMMARY

This policy paper has been produced by EY Climate Change and Sustainability Services on behalf of Alstom as a contribution to the debate at COP27 – the 2022 United Nations Climate Change Conference. Its findings demonstrate how increased investments in urban rail transport in Africa can facilitate the avoidance of substantial carbon emissions and contribute to broader sustainability goals, delivering environmental, social and economic benefits for Africa's growing cities.

Africa faces major urban mobility challenges, including poor air quality and rising carbon dioxide (CO_2) emissions from transport. The continent's urban population will increase from 600 million in 2021 to over 1.3 billion in 2050, with this growth contributing to sprawling urban areas. The combination of urbanisation and economic development leads to an increasing need for mobility and to a rapid motorisation of urban transport. These trends bring significant negative externality costs for the African population, including rising carbon emissions, air pollution, congestion and accidents. Congestion in particular is a key mobility challenge, as it is expected to cost Africa USD 488 billion in 2030. The challenge is therefore to reconcile the growing mobility needs of African cities, with the imperative for climate action and improved resilience.

Urban rail can meet the growing demand for mobility in Africa, while reducing urban transport CO_2 emissions. If the modal share of urban rail in African cities reaches 10% in 2030 and 20% in 2050 (compared to the baseline scenario where the share of rail remains at its current level of 1%), a cumulative total of 1 gigatonne of CO_2 will be avoided between 2023 and 2050. 173 million additional tonnes of CO_2 will be avoided between 2023 and 2050 if urban rail systems are powered exclusively with renewable energy.

Additional social and economic benefits will be captured by African cities that invest in urban rail. If the aforementioned modal shares of urban rail are achieved, almost 8 million cars could be removed from the road each day in 2030 and almost 29 million in 2050, leading to a significant decrease in congestion, road accidents and air pollution. Urban rail also provides more affordable and accessible transport than cars and informal transport systems, improving access to jobs and key services. This shift from road to rail could also support job creation in Africa. For example, a 60-kilometre urban rail project would create over 13,000 direct jobs for the construction of infrastructure and almost 2,000 for the operation and maintenance of the transport system.

Greater Cairo is an example of a city in Africa that has made significant investments in urban rail. Between 2023 and 2050, planned expansions of the city's network will allow the city to avoid a cumulative 35 million tonnes of CO_2. Additionally, it will provide the city with the significant aforementioned social and economic advantages, including a sharp reduction in congestion, a key benefit as congestion is estimated to cost Egypt USD 8 billion each year in the Greater Cairo Metropolitan Area.

Policymakers should act quickly to lay the institutional, financial and human foundations for urban rail projects to succeed. Urban rail mobility should be integrated into local and national development policies to enable long term planning and secure higher investments. Urban rail development will require a clear split of roles and responsibilities between local and national institutions, to ensure a conducive environment for private sector participation. Cities should anticipate the diversification of their funding sources to ensure projects are financially viable and should organise training to ensure there is a skilled workforce able to participate in and sustain the urban rail projects. To increase demand for urban rail among citizens, awareness campaigns should be launched and a fair pricing competition should be set amongst transport modes, to reflect the lower external costs of urban rail compared to road vehicles (especially cars). All of these actions should be implemented as soon as possible: if investments in urban rail are not made before 2030, the estimated potential decarbonisation benefits will likely not be realised by 2050. To quickly launch operations and lower costs, underutilised rail networks may be rehabilitated and the purchase of second-hand trains can be considered.

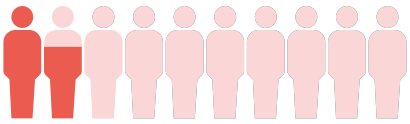
1 URBAN MOBILITY STATUS AND CHALLENGES IN AFRICA

CONTEXT: **GROWING URBAN MOBILITY CHALLENGES**

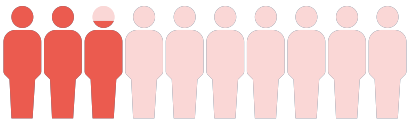
Africa is experiencing a strong demographic increase coupled with rapid urbanisation

Share of Africa in global population

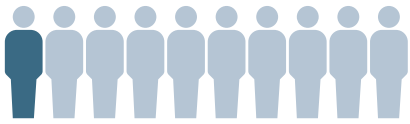
2021



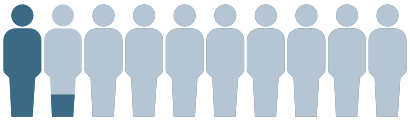
2050



Share of Africa's urban population in global population



In 2021, 1.6 out of 10 people in the world are African, of which 0.8 live in African cities.



In 2050, 2.9 out of 10 people in the world will be African, of which 1.2 will live in African cities.

Africa is undergoing a profound transformation, with population and urbanisation growing faster than any other continent. The African population is expected to almost double from 2021 to 2050 and the urban population is expected to increase from 600 million to over 1.3 billion[1]. To cater for this growth, cities are rapidly expanding, often beyond their administrative boundaries, engulfing smaller cities and towns, as well as semi-urban areas and rural hinterlands. This rapid urbanisation often puts significant strain on local authorities' planning and organisational capacities[2]. At the same time the concentration of people and activities that increased urbanisation brings socio-economic and environmental opportunities, such as increased economic growth[3] and resource efficiency[4].

Transport is crucial to economic development, providing access to work, education, services and leisure, but it continues to be one of the largest contributors to global carbon dioxide equivalent (CO_2) emissions[5], responsible for around 27% of the global energy related CO_2 emissions[6] and almost 25% at African scale. In cities, limited transport infrastructure and polluting vehicles lead to congestion, pollution, accidents and noise. This is the reality in many African cities, which have strong dependencies on informal transport (informal "minibus-taxis" being the most prevalent informal public transport today in Africa[7]) often offering low quality of service and poor safety[8].

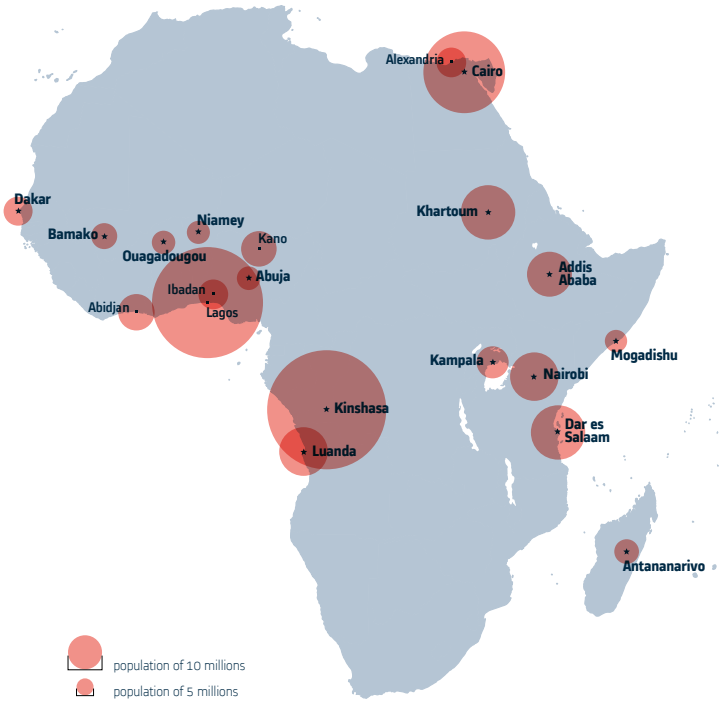
THE BRT SYSTEM

Bus Rapid Transit Systems (BRTs) can be a good transport solution for some cities, as infrastructure requirements are lighter than urban rail systems and often allow the use of existing infrastructures (e.g. roads). However, BRT's environmental footprint is higher than urban rail systems such as tramways. A diesel BRT's total lifetime emissions are more than twice as high as the ones of a tramway system, and even a fully electric BRT system has 17% higher lifetime emissions[9]. Even in countries with a carbon-intensive energy mix, a tramway's carbon footprint remains lower than a BRT system on a 30-year lifetime. BRT is not considered in this study which focuses on urban rail.

Economic growth in Africa has led to rapid motorisation of urban transport in recent years. The effect is demonstrated by an increase in private vehicle ownership of over 10 percent annually in most cities, albeit from a low base of less than 50 vehicles per 1,000 population in 2000 to over 200 vehicles in 2015 and still growing[10]. This increase in vehicle ownership conflicts with the commitments of African countries to meet ambitious climate targets and to manage air quality in urban areas. Eight out of the 19 countries that have included transport greenhouse gas emission targets in their second-generation Nationally Determined Contribution (NDCs, new or updated as of 10 April 2022) are African[11]. Thirty percent of Avoid-Shift-Improve actions in African NDCs focus on enabling a shift towards collective transport (buses and rail), walking and cycling[12].

In the context of projections of more frequent extreme climate events, along with the increase of urban CO_2 emissions, cities and governments around the world need to implement urban climate mitigation and adaptation strategies[13]. By developing sustainable formal public transport systems that connect city centres with expanding urban areas, African cities have the potential to improve the quality of life for their citizens whilst lowering the growth rate of emissions. Addressing these expanding mobility needs is therefore both a challenge and an opportunity for African cities[14]. Sustainable solutions will help decouple the relationship between the growing demand for urban mobility and its current highly emissive fossil fuel dependency.

Forecast of Africa's largest cities in 2050

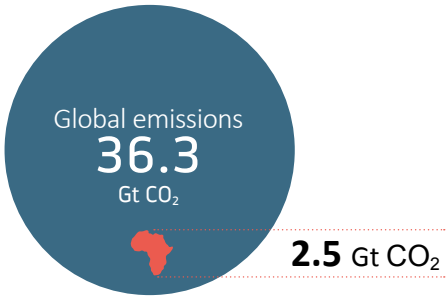


Public transport infrastructure is being developed at a slower pace compared to African cities' rapid expansion

As transport is a significant part of the CO_2 emissions in Africa[15], public transport is the only way to reconcile the increase in mobility needs with Africa's emission goals in line with the Paris Agreement, signed by all 54 African countries. With cities responsible for an increasing share of African transport demand, they represent an opportunity for climate action. In 2015, 38% of the CO_2 emissions in Africa came from cities[16], making mitigation efforts at the local level an important contributor to decarbonisation. Twelve African cities are members of C40 Cities, a network of mayors aiming to deliver the actions needed to confront the climate crisis.

In 2021, Africa was responsible for 7% of global energy-related CO_2 emissions

(Source: UNFCCC)



According to the IPCC's Sixth Assessment report, "cities can reduce their transport-related fuel consumption by around 25% through combinations of densification and the provision of less car-dependent transport infrastructure". Most urban transport emissions come from vehicles[17], as individual cars and low-occupancy taxis are carbon inefficient. A low-carbon development trajectory must therefore promote the use of considerably more carbon-efficient modes of transport including walking, biking and public transport, whilst also supporting sustainable development objectives for liveable cities, social inclusion, clean air and traffic safety[18]. To that end, expansion of effective and well-designed public transport by 2030 is a target set by the 11th goal of the United Nation's Sustainable Development Goals, aiming at making cities and human settlements inclusive, safe, resilient and sustainable[19].

"By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all"

Sustainable Development Goal 11 - Target 11.2

COP27, taking place in Egypt, is an opportunity to highlight the importance of decarbonising urban mobility

Urban rail is made of various types of rail systems – tramway, metro, monorail, suburban rail – all of which provide passenger services within and around urban and suburban areas.

Increasing the provision of urban rail represents a golden opportunity for African cities to meet their residents' growing demand for mobility, while managing their environmental footprint: urban rail produces up to 7 times fewer greenhouse gas emissions per passenger kilometre than cars (urban rail has an emission factor of 26 gCO_2/passenger.km, of which 7 gCO_2 is due to the construction of infrastructure, compared to the car's emission factor of 180 gCO_2/passenger.km); it emits less pollution than other urban transport modes and it better preserves landscapes, biodiversity, soil and water[20].

To date, Africa has not substantially developed urban rail in its cities. Only a few African cities have urban rail infrastructure in place, and emphasis on expanding railway networks, with exceptions like South Africa and North African countries, is not equal to that observed in other parts of the world[21].

Existing urban rail systems in Africa[22]

2 URBAN RAIL, A KEY MOBILITY SOLUTION FOR A SUSTAINABLE AFRICA

2.1 INVESTING IN URBAN RAIL CONTRIBUTES TO CLIMATE CHANGE MITIGATION IN AFRICAN CITIES

By investing in urban rail, African cities could contribute significantly to mitigating climate change by avoiding up to 1 gigatonne of CO_2 between 2023 and 2050

The transport sector is crucial to economic growth and development. It is also one of the largest contributors to global greenhouse gas emissions – the sector's emissions have grown faster than almost any other sector over the past 50 years[23]. Investing in urban rail represents one of the most efficient solutions for reducing urban transport CO_2 emissions; it can therefore play a key role in reaching the ambitions of the Paris Agreement as road transport emissions are growing fast in developing nations, like those in Sub-Saharan Africa[24].

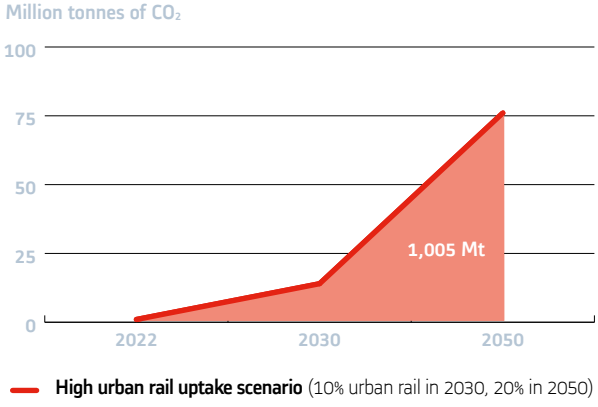
By increasing the modal share of urban rail to 10% of total urban mobility in 2030 and 20% in 2050 (compared to the business-as-usual scenario of maintaining the current share of 1%), Africa could see a reduction of urban transport emissions of 76 million tonnes in 2050, or 19% of the business-as-usual forecast. Cumulatively from 2023 to 2050, this scenario would result in the avoidance of a total of 1,005 million tonnes of CO_2 emissions. These figures include the CO_2 emissions from building new urban rail infrastructure, but do not include the CO_2 emissions from building roads, considering those are already in place.

The substantial emissions savings come from the superior energy efficiency and lower emissions intensity of urban rail compared to other powered transport modes in urban transport[25]. This is particularly the case when increased urban rail provision takes modal share from relatively energy inefficient cars. Cars in Africa are often older and larger than in other continents and therefore emit more CO_2 per kilometre than in developed countries[26]. At the same time, African countries also suffer from reduced access to highly efficient vehicle technologies. For instance, a comparison of the new South African passenger car fleet in 2020 with that of Europe show that the South African fleet emits, on average, 22% more CO_2 per kilometre than the European Union fleet[27].

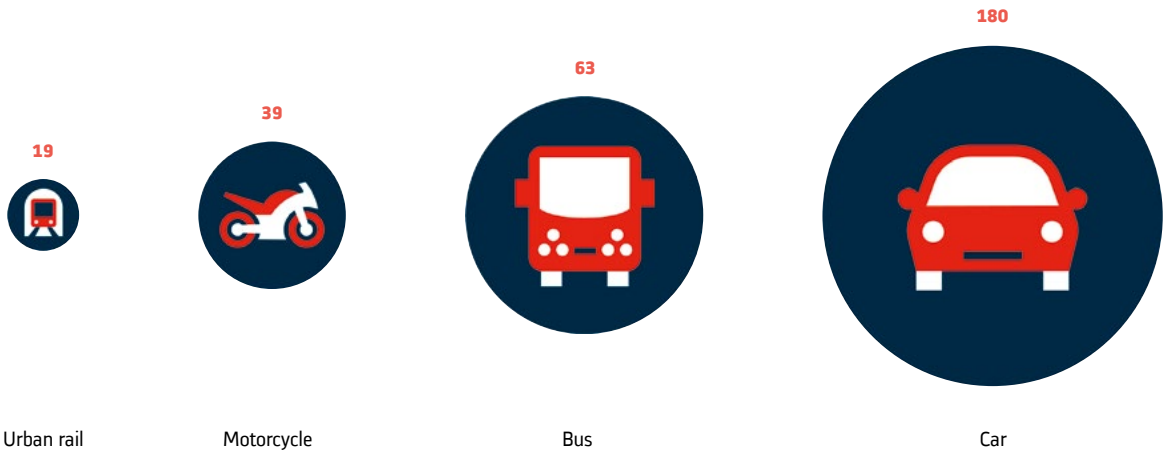
Urban rail also contributes to higher CO_2 emissions reduction than other public transport solutions, such as buses, as shown in the emission factors presented on the next page.

1,005 Mt CO_2
avoided by 2050

Avoided CO_2 emissions by 2050



The low-emission nature of urban rail is reflected through the following emission factors used for African transport modes in this study (gCO_2eq/passenger.km, worldwide from IEA, without the impact of infrastructure construction)[28] :

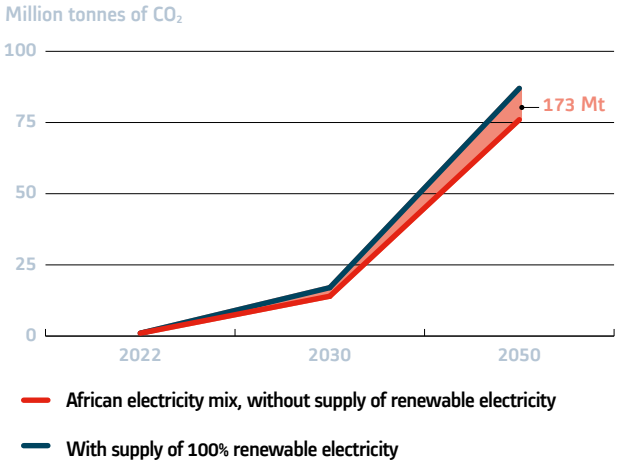


Compared to other transport modes such as cars, buses and even conventional rail, urban rail systems are a more efficient use of land footprint and can be run at rapid intervals, providing more efficient transport. Urban rail also has lower CO_2 emissions per passenger-kilometre than other modes of transport. Even when considering the impact of urban rail infrastructure in emission factors (+7gCO_2eq/passenger.km for urban rail emission factor), urban rail still emits less CO_2 per passenger.km than other urban transport solutions.

As a substantially electrified transport mode, urban rail's emissions have an advantage over other modes and will continue to improve as the share of renewable energy in the African electricity grid continues to grow rapidly[29]. This will ultimately result in emissions from the rail sector decoupling from its energy consumption requirement.

Independently from national energy policies, urban rail transport operators can choose to shift to green electricity directly, either by developing on-site green electricity generation or via a corporate Power Purchase Agreement (PPA). For example, the Sydney metro ensures a supply of 100% renewable electricity through a contract with a solar farm[30]. Estimating the further emissions savings if all urban rail in Africa was powered by 100% renewable energy, Africa could avoid a further 173 million tonnes of CO_2 emissions between 2023 and 2050, assuming a modal share for urban rail of 10% in 2030 and 20% in 2050.

Avoided CO_2 emissions by 2050 thanks to urban rail, with and without supply of renewable electricity



Urban rail remains highly efficient whether it is powered by renewable electricity or by the local grid.

2.2 FURTHER SUSTAINABILITY BENEFITS INCLUDE IMPROVING THE QUALITY OF LIFE FOR AFRICAN CITIZENS AND SUPPORTING ECONOMIC DEVELOPMENT

Urban rail development enables African countries to create economic value

Most African countries experience common obstacles for their economic development, including a high level of informal employment (accounting for 81% of jobs in Africa)[31].

Increased investment in urban rail can play a big part in the creation of formal, inclusive and secure jobs in Africa. For each kilometre of urban rail, it is estimated that 258 direct[32] and formal jobs are created in Africa, including 226 for the construction of infrastructure and 32 for operation and maintenance. Urban rail systems require operation and maintenance jobs over their entire lifespan, whereas the construction phase often generates short-term jobs (a few years). Additional direct jobs may be created when investments are made locally for the construction of rolling stock.

258
direct jobs created per km of urban rail

In addition to the creation of jobs, urban rail can bring benefits through localised economic development and through urban planning improvement. Many jobs are sustained in the local economy as a result of the spending of wages by urban rail businesses' employees. Attractivity and value increase for businesses and housing in proximity to rail stations, known as the multiplier effect. Developers, investors and entrepreneurs capture the commercial opportunities that arise from the creation of new transport oriented nodes, by undertaking commercial projects (such as building retail space, restaurants and hotels inside or next to stations)[33]. Coordinated and long-term urban planning can improve inhabitants' quality of life and wellbeing.

EXAMPLE: **THE ELIZABETH LINE IN LONDON**

The Elizabeth line was opened in 2022, allowing Londoners to commute through 42 kilometres of new tunnels. The Elizabeth Line promotes economic growth; by 2026, it is anticipated that, within 1 kilometre of Elizabeth Line stations, 180,000 new dwellings will be built, and that the value of surrounding real estate will rise by USD 23 billion. Along the route, the average property value is expected to increase by 29% for residential purposes and by 14% for offices. New workspace opportunities are expected to be created, enabling additional jobs to be accommodated[34].

Urban rail also partially breaks the cycle of automobile dependence, leading to better living standards and higher social inclusivity

Many African cities are struggling to break the cycle of automobile dependence[35]. As individual motorisation of transport increases, urban population density declines and metropolitan areas become more expensive for public transport to serve[36]. As a result, the desire for automobile ownership rises, promoting further urban sprawl and increasing traffic[37].

Urban rail development in African cities can help reduce increasing personal motorisation rates, by providing a safe, attractive and affordable alternative for residents. This can aid in

28.9
million cars off the road every day in 2050

partially breaking the cycle of automobile dependence, through the removal of almost 8 million[38] cars from the road per day in 2030 and almost 29 million[39] per day in 2050, across Africa. This will bring a number of benefits to African citizens.

Removing cars from the roads improves air quality. Growing traffic and ongoing congestion in many African cities increases air pollution, further worsened by an aging fleet and the increased use of motorcycles. African cities that monitor air pollution have levels of small particulate matter significantly above safe levels recommended by the World Health Organization (WHO) and this will continue to worsen as the number of light-duty and heavy-duty vehicles (passenger cars, trucks, buses) is expected to double in developing countries within the next two decades[40]. While the annual urban mean concentration of PM2.5 has decreased worldwide (going from 37.22 in 2010 to 33.06 in 2019), it has increased by almost 5% in urban regions of Africa, reaching 34.80 in 2019[41]. In African cities the concentration even reached 36.90 in 2019, 12% higher than the average concentration in cities globally[42]. In 2019, for every 100,000 of population, 1,705 disability-adjusted life years (DALYs)[43], representing the equivalent of years of full health, were lost in Africa due to ambient air pollution, compared to 947 on average in the rest of the world[44]. This issue of air quality also hinders Africa's economic development: for example, in June 2001 the Africa Transport Policy Program (SSATP) Technical Note 33 estimated the cost of air pollution in Cotonou, Dakar and Ouagadougou at 1.2%, 2.7% and 1.6% of the national GDP, respectively[45].

The avoided car uptake will also lead to lower road accidents and resulting deaths than in a business-as-usual scenario. Sub-Saharan Africa and North Africa both experience the highest mortality rates caused by road traffic injuries in the world, with 27% and 19% of deaths per 100,000 inhabitants[46] coming from road traffic accidents, compared to 17% in the world and 6% in the European Union for example. Urban rail causes far less accidents than cars: according to Injury Facts, over the last 10 years in the United States, passenger vehicle death rates per 100 million passenger.km were over 17 times higher than for passenger trains[47].

As a result of sprawl induced by the cycle of automobile dependence, many inhabitants of African cities currently cannot easily access the areas where job opportunities and essential services (e.g., education and health) are provided, engendering a poverty cycle[48]. According to the World Bank, the average African city is 20% more fragmented than cities in Asia and Latin America and suffers from 37% less exposure to people (hence fewer social interactions) and jobs[49]. Urban rail development connecting remote urban areas to city centres allows residents to commute farther, thereby reducing social inequalities.

Urban rail also reduces dependency on informal transport[50], which the elderly and disabled in particular may find difficult to use and in which some studies show that women fear harassment[51]. When urban rail is designed to be a formal, safe and easy-to-access means of transport, women, the elderly and the disabled have better chances of accessing services, increasing inclusivity and their participation in society[52].

Households' purchasing power benefits from urban rail, while their transport time declines

Provision of affordable urban railways reduces households' transport budgets, improving their purchasing power while enabling them to have access to lower-cost transport services. In Sub-Saharan Africa, many people cannot afford to buy a new vehicle[53], preventing them from commuting far from their neighbourhood. Even though an increasing share of residents may become able to afford a car due to economic growth, use of urban rail could drastically decrease their transport budget: on average at least 70%[54] less is spent on urban rail than on cars in Africa for commuting purposes (including the cost of purchase of a car). This cost reduction would be even higher if pricing mechanisms that reflect the higher external environmental, economic and health costs of motorised vehicles were put in place.

Many African cities suffer from severe traffic congestion. Congestion is generally understood as the result of too many vehicles using under-dimensioned road infrastructure, but studies show that congestion in urban Africa also results from poor traffic and parking management. This congestion, in turn, is a significant cause of the low speed and poor time-reliability of bus and informal public transport, driving users to prefer individual cars over public transport, a trend that ultimately leads to further increasing congestion. This time lost in transport directly affects countries' GDP, as these lost hours could alternatively be time used for value generation.

488

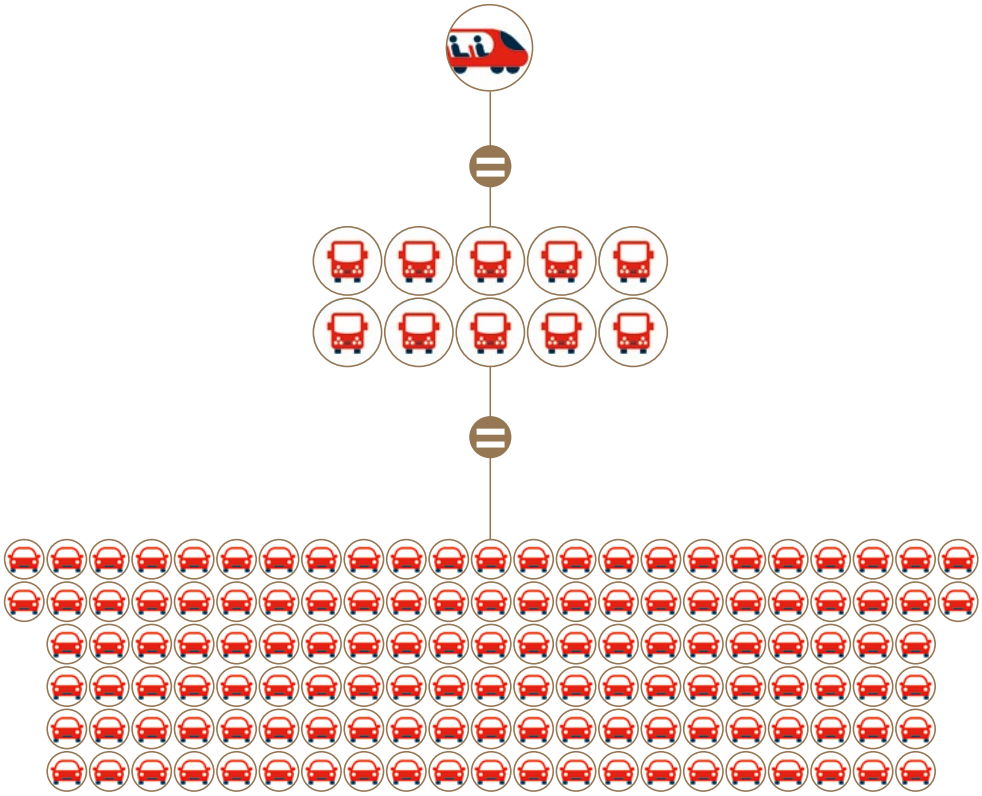
billion USD of costs linked to congestion in 2030

Urban rail development helps decongest cities: if a passenger uses urban rail instead of a car, they can reduce their commuting time. Currently, costs linked to congestion represent a total amount of USD 314 billion in Africa[55], and this is expected to reach USD 488 billion in 2030.

This lowered congestion time is partially enabled by the advantageous spatial footprint of urban rail, compared to cars. Urban rail systems, made of separated systems (either with reserved tracks or grade separation), promote a more compact urban form that facilitates efficient use of scarce resources (such as land) and that promotes densification processes leading to positive impacts on economic vitality and on access to opportunities[56]. Urban rail systems such as monorails have even lower spatial and resource footprints, thanks to the possibility of constructing light infrastructure above existing roadways. In comparison, private motorised transport modes have a high impact per passenger on road space: for example, in a 3.5-metre wide lane, heavy rail has a capacity of 80,000 people per hour whereas cars in mixed traffic have a capacity of 2,000 people per hour[57].

Three modes of transport with 200 people each

One X'Trapolis train carriage or 10 buses or 130 cars



3 CASE STUDY: CAIRO, A CITY WITH STRONG URBAN RAIL DEVELOPMENT

The case of Greater Cairo is examined in detail within this study, with the city having begun developing urban rail in 1982, when it started building Africa's first metro system, Cairo Metro Line 1. Greater Cairo now has three metro lines in operation and several on-going expansion projects including two additional metro lines and two monorail lines.

This case study aims to analyse the benefits of this investment in a strong urban rail transportation system to demonstrate the potential benefits similar development could bring to other cities in Africa. The study area of Greater Cairo includes Cairo as well as the new cities of New Cairo City, 6th of October City, 15th May City, 10th of Ramadan City, El-Obour City and Badr City[58].

To overcome urban mobility challenges, Greater Cairo started to invest in urban rail in 1982

Greater Cairo hosts more than one-fifth of Egypt's population[59]. Its population has grown from 7 million in 1980 to 21 million today[60] and is expected to reach 38 million by 2050[61]. The city has expanded over more than 50 linear kilometres from the metropolitan centre to the inner-metropolis districts, while the inner-city areas have increased in density, creating significant urban mobility challenges[62]. In 2019, the city's CO_2 emissions due to transport represented 40% of Egypt's total transport emissions (54 million tonnes of CO_2)[63], amounting to around 22 million tonnes of CO_2[64]. The country faces an increase in car ownership, which is currently growing 4.2% faster than income, with 215,000 new passenger cars sales in 2021[65]. The rising number of cars on the road leads to significant costs of congestion, which are estimated at 4 to 5% of GDP[66], and causes many road accidents, with around 1,000 fatalities and 4,000 injuries per year in Cairo[67] alone.

Decarbonising transport is a key priority for the Egyptian government and Egypt is committed to meeting the goals of the Paris Agreement[68]. Urban rail development is therefore an important part of facilitating this decarbonisation; for instance, Line 3 of the metro was forecast to reduce CO_2 emissions by roughly 133,000 tonnes of CO_2 annually, according to a feasibility assessment by the Agence Française de Développement (AFD)[69].

The Egyptian government also aims at countering increased dependence on imported fossil fuels. According to Egypt's Integrated Sustainable Energy Strategy to 2035 (ISES 2035) [70], the import reliance rate on fossil fuels reached 10% in 2014–15 and is anticipated to increase to 50% in 2034–35[71]. In urban transport, this boosts the attractiveness of electrified rail networks.

Greater Cairo has thus invested in several urban rail projects:

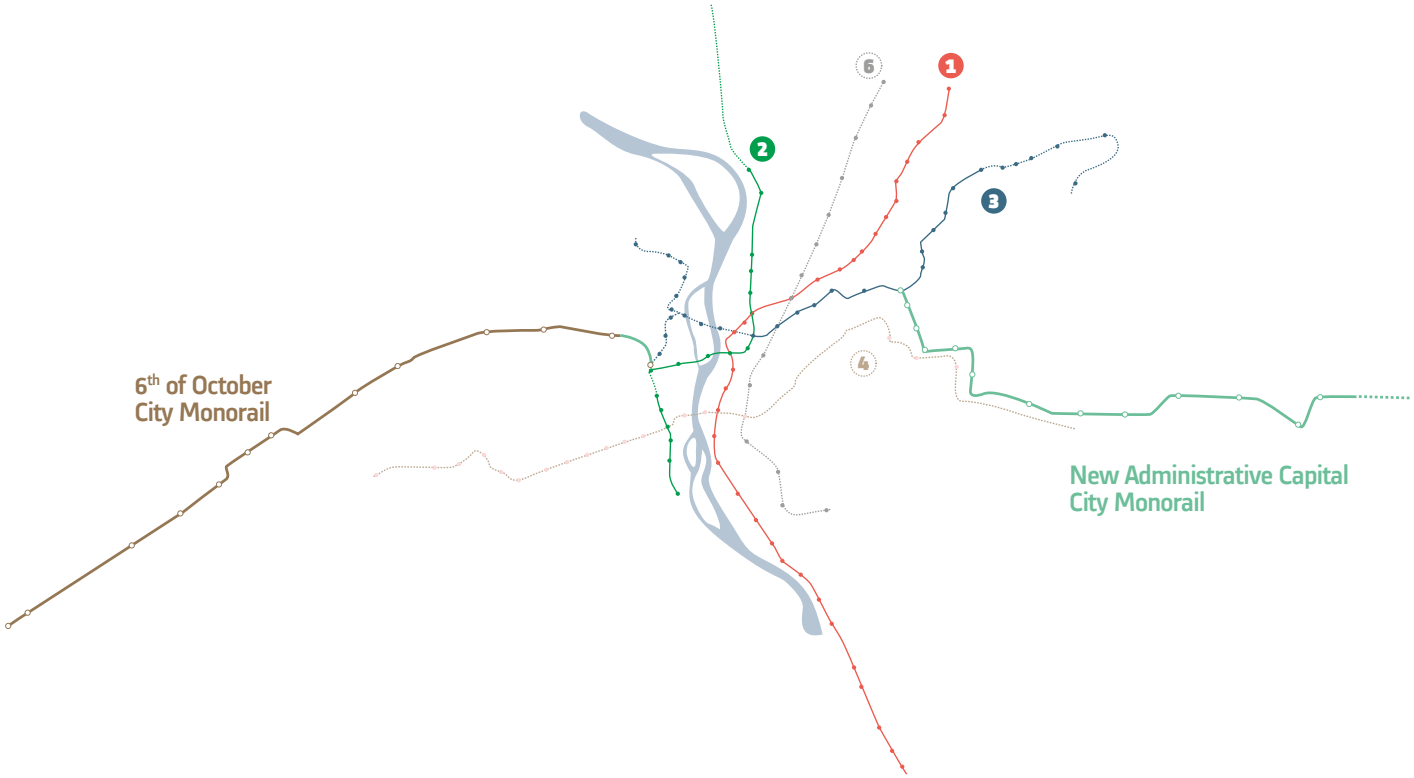
Metro lines:

- Line 1, 44 km length for a daily transportation capacity of 2.5 million people
- Line 2, 22 km length for a daily transportation capacity of 1.8 million people
- Line 3, 30 km for a daily transportation capacity of 1.5 million people
- Lines 4 and 6 are planned and will result of a total network length for Greater Cairo of more than 150 kilometres.

Monorail: the two lines of the monorail will connect East Cairo to New Administrative Capital City and 6th of October City to Giza.

Cairo Light Rail Transit: 90 km length linking Egypt's New Administrative Capital and the 10th of Ramadan City.

Greater Cairo urban rail network



Greater Cairo should be able to reduce its CO_2 emissions by 35 million tonnes of CO_2 between 2023 and 2050 as a result of its under construction and planned urban rail projects

By investing in urban rail, Cairo has managed to start a shift from motorised vehicles to urban rail transport, leading to a decrease in its transport emissions. Continuing on this path, Cairo is investing in several additional urban rail projects, such as the two new monorail lines. Such additional urban rail projects will enable the city to avoid the emission of 35 million tonnes of CO_2 between 2023 and 2050. This figure includes the CO_2 emissions from building urban rail infrastructure, but does not include the CO_2 emissions from building roads, considering those already in place.

Electrified rail mobility also benefits from the planned decarbonisation of the Egyptian electricity grid, enabled by the rising share of renewable energy generation. The Egyptian government has set ambitious goals for the growth of renewable energy. The Integrated Sustainable Energy Strategy to 2035 (ISES 2035)[72] includes a target to reach 42% of renewable energy in the total installed capacity by 2035. The Minister of Petroleum and Mineral Resources Tarek El-Molla announced during COP26 that Egypt will bring this target forward and aim for 42% of renewables in its energy mix by 2030[73].

If a further step is taken and a 100% renewable electricity supply is secured for Greater Cairo's urban rail transit system, further carbon emission reductions would be made. This could be done by making investments in on-site green electricity supply and by signing a PPA (Purchase Power Agreement) if available. By using only green electricity for urban rail, an additional 7 million tonnes of CO_2 could be avoided between 2023 and 2050.

Urban rail development in Greater Cairo should enhance local development and improve inhabitants' living standards

Urban rail development enables Greater Cairo to create economic value, to partially break the cycle of automobile dependence (leading to better living standards and higher social inclusivity) and to help its inhabitants save commuting time and decrease spending.

Thanks to the planned urban rail projects, at least 7,000 additional jobs are expected to be created for the construction of infrastructure and 4,000 for the operation and maintenance.

In addition to job creation, the deployment of rail also benefits the local economy through economic development around stations. As Greater Cairo is expanding and includes new cities, the creation of monorail lines (which link different zones of Greater Cairo) offers new and much needed transport options to these key areas. People currently living in the centre of Cairo will be able to go to work in these new cities and housing will be able to develop in these cities for people who cannot live in the centre of Cairo.

- The East Nile Monorail will be connected to the third metro line and will link the areas of Nasr City, New Cairo and the Administrative Capital. The full route between New Cairo and the New Administrative Capital City will be a 61-minute journey by Monorail. It will facilitate the movement of employees and residents from Cairo and Giza to New Cairo and the New Administrative Capital City[74].
- The West Nile Monorail will be connected to the fourth metro line and will link the Greater Cairo Region with the new urban areas (New 6th of October City) as well as the industrial zone in 6th of October City. While it takes about 2 hours by car to travel from Giza to October 6th Industrial Zone, it will only take 40 minutes by monorail. It will serve the large expansions in the city of 6th of October, including social housing projects, development projects south of 6th of October and southern expansions[75].

The urban rail network in Greater Cairo currently avoids the use of around 175,000 cars every day. Thanks to the additional urban rail projects, the use of 595,000 cars is anticipated to be avoided. These avoided car journeys will lead to less air pollution, less road accidents, and therefore less health and safety-related issues. Also, urban rail commuting enables a reduction of time spent in transport due to congestion, a key benefit since congestion costs are estimated at USD 8 billion in Cairo in 2010 and expected to reach USD 17 billion in 2030. This saved transport time is also a key factor for the development of New Capital City and 6th of October City, as high congestion and transport time could have been an obstacle for many inhabitants to commute between these cities and Cairo.

Finally, even though urban rail development enables the commute of many more people each day, its spatial footprint is low compared to road infrastructure and its impact on biodiversity is minimal. For example, a significant part of the monorail lines has been constructed between and above existing large roads, therefore limiting the spatial footprint required.

4 KEY RECOMMENDATIONS FOR POLICYMAKERS

By investing in urban rail, growing African cities can manage urban mobility issues, reduce CO_2 emissions, enhance economic development and improve quality of life. In order to ensure Africa can harvest the benefits highlighted in this report, such urban rail investment should be made rapidly. Institutional, financial and human foundations should be established now to ensure the viability and success of urban rail projects. The recommendations that follow are intended to provide some guidance to how such a base can be built.

INTEGRATE URBAN RAIL IN LONG-TERM URBAN PLANNING

Urban rail mobility should be integrated into local and national development policies[76] to allow longer term planning, both for rail development and for urban development, and to secure higher levels of investment. Through improved local urbanisation plans, a rigorous town planning approach will ensure urban development has more sustainable outcomes, leading to denser cities with efficient public transport backbones (including buses to and from the main stations and nodes and facilitating active travel like cycling and walking for last mile connectivity).

In Senegal, the CETUD has developed the Sustainable Urban Mobility Master Plans (PMUS 2035) for Dakar and deploying the same in 5 regional capitals cities in the country. These urban mobility master plans, which are part of both the national land-use policy and the national policy on urban development, are planning instruments for medium- and long-term urban development (15 to 20 years) and serve as a basis for integrated mobility planning.

ESTABLISH FRAMEWORK CONDITIONS TO FACILITATE PUBLIC – PRIVATE COORDINATION

Funds from the private sector can contribute to the achievement of urban rail projects provided that strong institutional and policy frameworks are established. A clear split of roles and responsibilities between local and national institutions, to ensure a conducive environment for private sector participation, are required to implement urban rail policies[78]. An adequate intervention framework for private urban rail operators can include operating contracts based on performance indicators, with the help of public service contracts for example, as well as service or management contracts[79].

As an example of partial private funding of a commuter rail project in Africa, the funding model of the Gautrain Project in South Africa involved a Public Private Partnership. This involved a private partner, the Bombela Concession Company, being granted a 20-year concession for the construction, operation and maintenance of the Gautrain, with obligations to provide a viable service[80].

SECURE THE FINANCIAL VIABILITY OF URBAN RAIL PROJECTS BY DIVERSIFYING FINANCING INSTRUMENTS

To overcome the common urban rail transport "underfunding trap", for up-front investments and operation costs, cities can diversify their sources of funding by[81]:

- Capturing part of the increased value of land located next to infrastructures like stations (e.g. through increased property taxes),
- Using motorised transport taxation for urban rail network investment costs,
- Developing partnerships with private companies for the construction and operation of infrastructure, and
- Mobilising concessional funding from international donors.

Following a funding objective set during COP16, USD 374 billion (72% of loans, 25% of grants and 3% of equity) was provided between 2016 and 2020 by developed countries for climate action in developing countries, of which 14% was dedicated to transport[82]. The extension of this funding objective to 2025 during COP21 could benefit African countries looking to develop urban rail.

ASSESS THE SKILLS REQUIRED FOR URBAN RAIL DEVELOPMENT AND DEVELOP AN ADAPTED EDUCATION AND TRAINING STRATEGY

Current and forecasted needs in terms of occupations and skills must be assessed to ensure that the right capacities are built in the labour market, leading to successful urban planning and transport development. Partnerships between companies and universities should be created to encourage the creation of courses on urban rail mobility[83] that are adapted to the market's needs[84]. The existing workforce should be upskilled, for example by benefiting from training programs funded by international organisations (World Bank, etc.). Agreements should be reached with private constructors or operators to enhance knowledge transfer to the local ecosystem and promote local content[85].

For the Dakar TER, thanks to a partnership with the companies SNCF/KEOLIS, 950 workers have been recruited and trained by the newly created SETER (Société d'Exploitation du TER de Dakar), among which 97% are Senegalese and 40% are women[86].

SET UP PRICING MECHANISMS AND BOOST PUBLIC AWARENESS TO INCREASE DEMAND FOR URBAN RAIL AMONG CITIZENS

As decision-makers and funders, public authorities have a crucial role to play in incentivising commuter commitment to urban rail instead of cars. They should raise awareness on the strong environmental and socio-economic benefits of increased provision of urban rail in Africa, to build public support for urban rail projects and to increase ridership, thus reducing motorisation rates. They should also ensure a fair pricing competition amongst transport modes, that reflects the lower external costs of urban rail compared to motorised vehicles (and especially cars), for example through charging mechanisms like congestion cost zones for private cars.

In Milan, Italy, the opening of the metro line M5, operated by Azienda Trasporti Milanesi, was widely advertised before it became operational. The project envisaged 130,000 passengers per day on weekdays, but ridership eventually increased to 180,000 passengers per day [87].

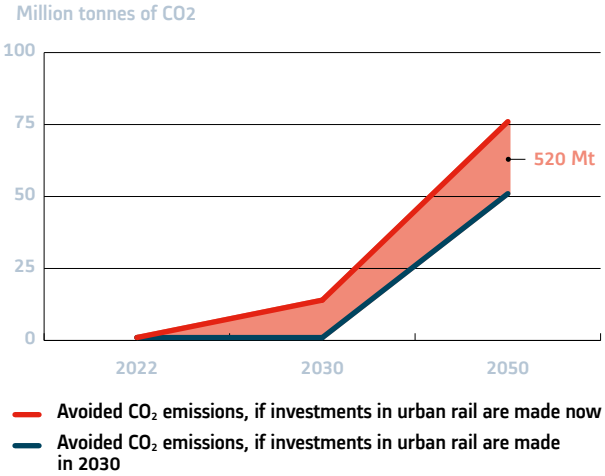
Start investing in urban rail now and not later

Policymakers need to invest in urban rail as soon as possible to reduce greenhouse gas emissions efficiently and rapidly. Several years may pass between the decision to establish urban rail, the completion of infrastructure construction and the start of operations[88]. If investments are not made before 2030, the aforementioned decarbonisation potential by 2050 will not materialise.

At the same time, the later investments are made, the more cities' urban development will benefit motorised vehicles, increasing residents' reliance on cars and raising the cost of future expenditures in urban rail.

Any investment to increase or improve urban rail mobility options for the community should therefore be considered as a step in the right direction. Underutilised rail networks may be rehabilitated and the purchase of second-hand trains can be considered, to launch operations faster and cheaper while simultaneously planning improvements and expansions. For countries that do not have existing networks, investments should target high-density areas to make the highest impacts.

Avoided CO_2 emissions with urban rail investments in 2023 vs 2030



EXAMPLE: **KENYA'S POLICIES**

In Nairobi, Kenya, policymakers wanted to quickly launch an urban commuter railway network to relieve congestion in Nairobi's centre. The city used part of its existing unused network, originally constructed to link the port of Mombasa with Uganda, and bought Mallorca's old diesel rolling stock. The city is now working with the industry to expand and improve the network through planned electrification, new electric trains and new signalling solutions[89].

METHODOLOGY

Avoided emissions

The "avoided emissions" indicator is the difference between the greenhouse gas emissions of a "Business as Usual" scenario and a "High Urban Rail Uptake" scenario, from 2023 to 2050.

The "Business as Usual" Scenario developed in this study is based on the "Recover Scenario" of the Organisation for Economic Co-operation and Development (OECD) urban passenger model. This model provides urban passenger transport volumes forecasts in passenger-kilometres from 2020 to 2050 for Sub-Saharan Africa and North Africa, for several transport modes (car, taxi, bus, urban rail, bicycle, walk...). This scenario assumes that governments will prioritise economic recovery, after the Covid-19 health crisis, by reinforcing established economic activities with little to no commitments to decarbonise transport. It assumes a constant modal share for urban rail of 1% of urban transport in Africa, from 2020 to 2050.

The "High Urban Rail Uptake" Scenario developed in this study assumes an increased urban rail modal share in Africa to 10% in 2030 and 20% in 2050, in line with the Net Zero Emissions Scenario from the International Energy Agency[90] (IEA).

For both scenarios, greenhouse gas emissions were calculated based on the IEA well-to-wheel greenhouse gas emission factors for motorised passenger transport modes[91]. For urban rail, an additional 7 gCO_2e/passenger km was added to the IEA emission factor to integrate the impact of infrastructure construction, based on an International Union of Railways (UIC) study[92]. The urban rail greenhouse gas emission factor evolution from 2022 to 2050 was projected based on the projected decarbonisation of the electricity mix in Africa. The motorised road transport (cars, buses) greenhouse gas emission factors evolutions from 2022 to 2030 were projected based on an International Council on Clean Transportation (ICCT) study on passenger vehicles CO_2 emissions in South Africa[93], and assumed to be constant after 2030.

Avoided emissions if powered with 100% renewable electricity

The "avoided emissions if powered with 100% renewable electricity" indicator has been calculated based on the same model as the "avoided emissions" indicator. The greenhouse gas emission factor of urban rail has been reduced to reflect the impact of procurement of 100% renewable energy. The emission factor of solar photovoltaic electricity has been considered as this technology is expected to become the main source of renewable energy by 2050 in Africa according to the IEA.

Jobs created

Jobs created in Africa for the construction of urban rail infrastructure and for the operation and maintenance of urban rail services have been estimated based on a sample of 12 urban rail projects conducted in Africa (8 projects), Middle East (1 project) and other developing countries (3 projects). Jobs created in Cairo were calculated based on the actual construction of the monorail lines. Jobs created for the manufacturing of rolling stock have not been considered in the study, as these jobs are not guaranteed to be local, depending on market size and the existence of production capacities locally.

Purchasing power

The "purchasing power" indicator compares the cost of commuting by urban rail and a private car. The total cost of car ownership has been compared to the average monthly cost of urban rail.

Total cost of car ownership includes the acquisition cost, fuel costs, insurance costs and running costs. Data has been extrapolated from South Africa, and adapted to reflect the contexts in North Africa and in Sub-Saharan Africa, with a cost of car acquisition estimated at between USD 8,000 and USD 14,000.

The average monthly price of urban rail is based on a sample of urban rail projects, located in Casablanca, Dakar, Cairo and Alger.

For Cairo, the same methodology has been applied, with precise data for cars acquisition cost, cost of fuel and metro monthly cost.

Costs of congestion

Costs of congestion in Cairo for 2010 and 2030 have been obtained through the Cairo Traffic Congestion Study: Final Report (World Bank, 2010). The 2010 results of this study are still considered relevant today by the World Bank, as shown in a recent article published for COP27[94].

Costs of congestion in Africa have been extrapolated from Cairo's results, comparing the number of inhabitants in Cairo to the urban population in Africa, in 2010 and in 2030. The urban population in Africa in 2010 and in 2030 has been estimated based on the World Bank data of 2020.

Cars off the road

The "cars off the road" indicator represents the number of avoided cars in Africa thanks to the use of urban rail. It has been calculated with the same model as for the "avoided emissions" indicator, considering that the urban rail modal share reaches 10% in 2030 and 20% in 2050. It is assumed that on average 1.5 people travel per car, with two daily journeys per car. The average distance per journey has been calculated based on the OECD model used for the "avoided emissions" indicator.

For Cairo, the number of avoided cars has been calculated based on the daily transportation capacity of the existing and of the planned urban rail lines. Identical assumptions in terms of number of passengers per car and of number of journeys per car have been used.

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