URBAN ROPEWAYS IN EUROPE


Image 1: Emirates Airline, London, M. Nuessgen, 2014

Creating opportunities in urban development

Matthias Nuessgen
Eurist - European Institute for Sustainable Transport
Weidenbaumsweg 13
21029 Hamburg

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Preface

by Prof. Kurt Bodewig, former German Federal Minister of Transportation and Infrastructure

This status report on the potential of ropeway systems for urban development in Europe is intended for transport and mobility practitioners and other stakeholders in the European region. It shall be an interesting source for all those who are involved in the improvement of urban public transport policies and in developing low-carbon and energy-efficient transport options for the citizens in Europe.

These days urban citizens and business suffer from congestion, air and noise pollution, as well as road accidents and there is need to act and change transport patterns in almost all cities.

From an environmental perspective it is obvious and ethically mandatory that cities need to contribute to the European climate change and energy efficiency targets. In this regard the 2011 published EU White Paper on transport stands as a new planning concept able to address transport-related challenges and problems of urban areas in a more sustainable and integrative way.

By 2050, the EU White Paper targets on urban transport include:

- No more conventionally-fuelled cars in cities.
- Higher share of public transport in cities, including a greater variety of mode choice for public transport users
- All measures contribute to a 60% cut in transport emissions by the middle of the century.

From a more social point of view this concept places particular emphasis on a long-term and sustainable vision for an urban area, taking account of wider societal costs and benefits like household travel costs, social inclusion, safety and quality of life.

The question will be how urban ropeway systems, also called cable car systems, successfully implanted in other regions of the world, can help to meet these targets.

As many European cities still grow and need to increase the share of public transport in their modal split, there is also need for tailor-made long term planning of urban transport, closely linked with urban development planning.

Here the 'Sustainable Urban Mobility Plan' (SUMP) - guidelines of the EU are of relevance. SUMPs are defined as strategic plans, designed to satisfy the current and future mobility needs of people.
In this context there is an overall agreement on the need to switch to cleaner transport and to make additional public transport choices more widely available. Cable cars might be one of such new innovative facilitators of better integrated urban mobility, including the transportation of bicycles potentially increasing the share of cycling.

But apart from the transport perspective, many of the cities mentioned in this paper do already experience a substantial positive effect of ropeway systems for their urban development, and justify the recommendation to other cities in Europe, in order to prove its applicability as a highly effective and environmentally friendly transport alternative and as a tool with a potential to create opportunities in urban development.

Content

1. An urban development tool?

The use of areal ropeways is rapidly gaining ground in developing regions like Latin America or Africa. In the fast growing metropolises of these regions, ropeways present a good possibility to start using a highly effective mode of public transport, which is faster and easier to implement and to operate than other transit modes, like Bus Rapid Transit (BRT) or Light Rail Transit (LRT). It is able to solve urgent issues in a very short range of time and is perfectly capable of cooperating with the mass transit modes once these start working.
Ropeways provide added value and less financial risk to the cities. They can even work as a catalyst for public transport by starting to create public support, institutional and technical know-how and economic resources for the implementation of the necessary mass transit modes like metros, BRT or LRT.

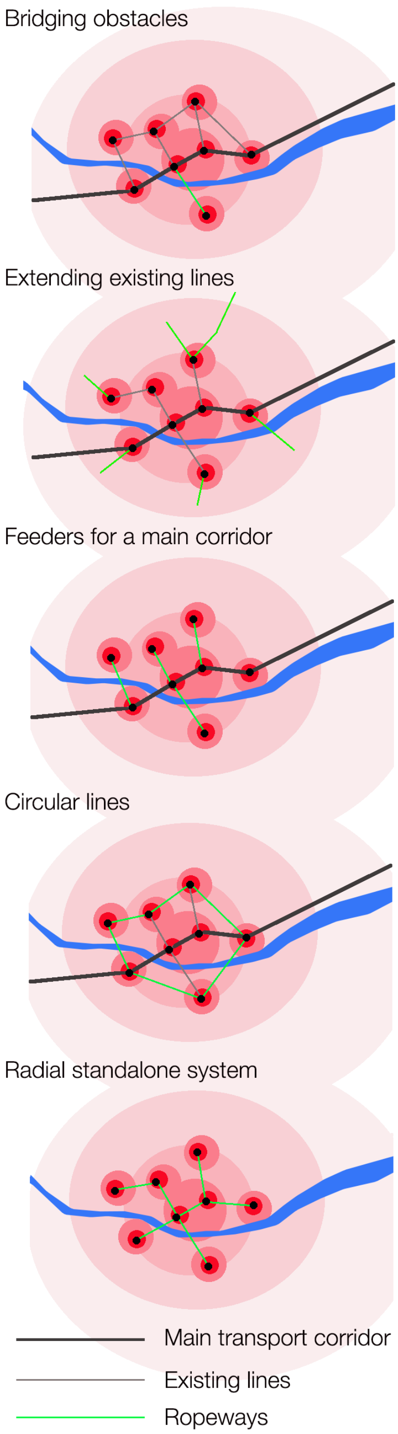

Image 2: Urban settings, M. Nuessgen

There are a variety of possibilities to implement gondolas in an existing transport system. In many cases, the first step will probably be a pilot system bridging a gap in the existing system. Gondolas can do this in a quick and efficient manner. In order to generate intermodality, gondolas may extend existing transport lines, work as feeder systems to main transport corridors or connect existing endpoints by a circular line. In smaller cities they can even serve as the main transport mode. One possible setup for this would be a radial system with one big central hub in the city centre and various radial spokes.
Amongst transport planners and urban designers, there are few doubts left that gondolas are a very effective and useful transport mode for a number of urban situations or conditions. But transport planning is more than an end in itself. It is often a very effective tool for urban development. Public transport in combination with walking and cycling becomes an increasingly viable alternative to the private car, a development which would give cities a whole new perspective of urban planning and the design of public space.
Especially in the big cities in Western Europe one can clearly see the trend of a shrinking motorisation at least in the younger age groups. Smaller and medium-sized cities do not yet follow this trend, probably due to the missing quality of their public transport systems, which cannot yet provide a viable alternative.

In Europe, cable cars are still not commonly considered a mode of transport able to solve urban transport issues. They are known, though, as temporary transport solutions for big events like the Olympic Games, EXPOs or horticultural shows.
There are a number of examples for this type of cable cars, starting with the Expo of Barcelona in 1929, followed by Seville 1992, Hannover 2000 and Zaragoza 2008.
Horticultural shows, like in Cologne 1957, Koblenz 2011, Venlo 2012 or in Berlin 2017, have been and will be equipped with cable cars.
Some of these examples still exist, but only few are good examples of what a cable car can achieve in terms of planning and urban development.

This article will examine some European examples in order to analyse critically the particular effects on urban development that cable cars are able to generate if implemented in an intelligent way.

Image 3: Cologne cable car, www.koelln.de

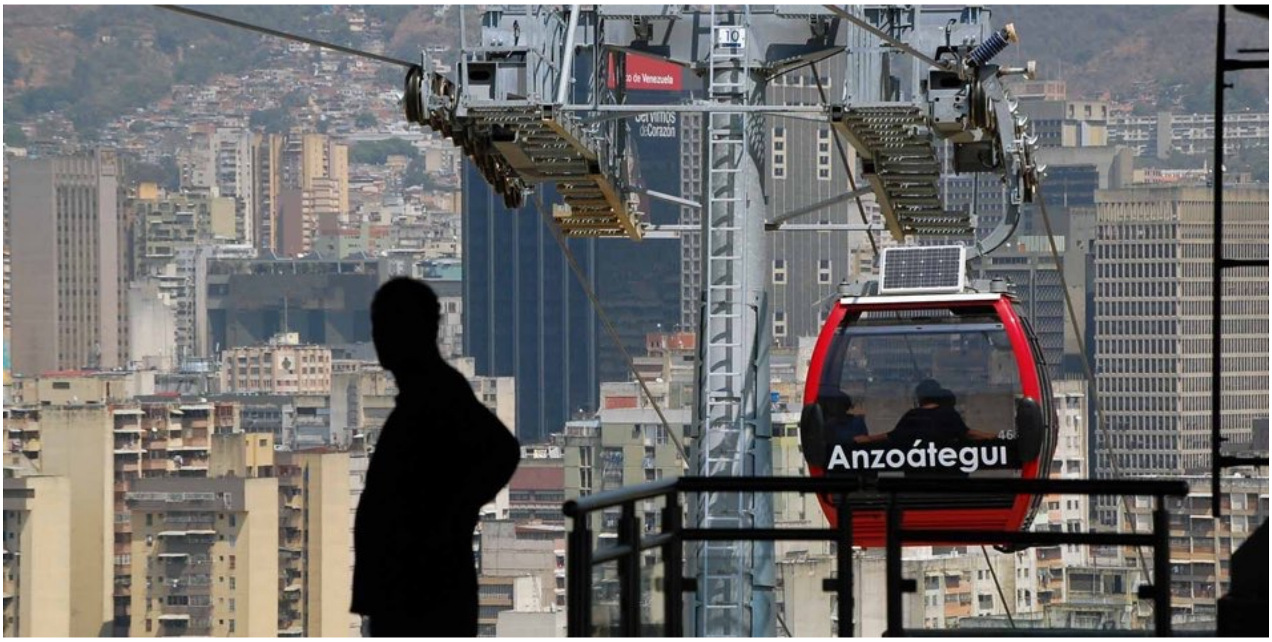

Image 4: MetroCable, Caracas, The Gondola Project, Steven Dale

The objective of every urban transport system is obviously first and foremost to solve existing transport problems. However, in some cases these solutions are so revolutionary that they offer new possibilities to the entire urban development. If they recognise this potential, planners are able to use these urban transport solutions as tools to initialise development projects.

Non-European examples of this effect are some of the ropeway systems installed in Latin America. Especially the systems in Medellìn and Caracas have not merely provided a transport mode when they where installed during the first decade of the new millennium. In areas that had been completely inaccessible for cars, let alone public transport, because of their density and their geographical conditions, ropeways have done more than just opening new connections towards the cities. They were accompanied by further innovations, like modular staircases and new walkways, which improved the accessibility within the neighbourhood. This development was stimulated by a station design which included basic water supply and sanitary facilities and established new cultural centres within the areas, offering internet access, libraries, sporting facilities only to name a few.
These projects where so successful that at the moment, just about 10 years after the first gondolas arrived in these cities, they already have big networks of cable cars.

Image 5: Map of the Caracas Metro, both current and planned stations, Licence: CC BY SA 2.5, Okty https://es.wikipedia.org/wiki/Metro_de_Caracas#/media/File:Mmap1vg1.gif

Ropeways tend to have this kind of potential due to their unique characteristics. They are often able to provide surprisingly simple solutions to rather old problems, solutions that nobody has really thought about or considered realistic before.

Aerial ropeways are able to bridge obstacles like rivers, highways, steep and hilly terrains or just dense car traffic. They are independent from existing corridors and only require a minimum of urban space, which makes them extremely low impact infrastructures, able to access high-density areas.
With a completely barrier-free station layout, gondolas are accessible for wheelchairs, bicycles or strollers, which makes them very passenger- and commuter-friendly. But not only travelling by gondola is barrier-free. Gondolas, unlike most other urban transport modes, do not create barriers on the ground for walking and cycling.
In Europe, ropeway projects still seem to encounter manifold obstacles in the planning or implementation phase. The reason for this may be that, due to the innovative capacity of the transport mode, flexibility and open-mindedness are often necessary in order to implement a system. Ropeway systems can alleviate many transport problems which have become widely acknowledged as development limits of the cities.
There are many different barriers to overcome, in administration, planning and politics, and also in the public opinion about ropeways.

The following table was designed by the German planning office 'Raumkom' in order to compare evaluation criteria for a variety of urban transport modes. The higher the value assigned to a transport mode, the better it performs regarding the chosen indicator.

While the aerial ropeway is often regarded as a niche solution, suitable only under very special conditions, the results of the table would indicate that it actually is the most flexible transport mode available, and and should clearly be considered for a wide variety of conditions.

Urban Transport mode/ Evaluation Criteria	Bus (Diesel)	Guided Bus (electric)	Tramway	Elevated railway	Tube	Aerial Ropeway
Capacity	1	1	2	3	6	2
frequency	1	3	3	4	5	6
investment / km	6	4	3	2	1	5
operating cost	3	1	2	3	4	6
externalities	1	2	3	6	6	6
impact on trafic	2	3	3	6	6	6
visual impact	5	4	3	1	6	2
noise emissions	2	3	2	1	5	5
gas emissions	1	3	5	5	5	5
energy consumption	1	2	3	4	5	6
surface sealing	4	2	5	5	5	6
flexibility of corridors	5	4	3	3	2	1
tourist attractiveness	2	4	3	5	1	6
gradient capability	3	4	1	2	2	6
necessity of space	3	2	5	4	6	5
accessibility	6	5	5	3	2	2
Total Points	**46**	**47**	**47**	**57**	**67**	**75**

Table 1:Comparison of evaluation criteria for urban transport modes, Raumkom, Urbane Seilbahnen, 2010

“The gondola technology is safer, cleaner, faster, cheaper, more efficient, more reliable and offers waiting times of less than 1 minute without the need of a schedule”.
(Steven Dale, http://gondolaproject.com/)

2. Cable Car Technology

Cable-propelled transit is able to move people or goods in engine-less vehicles that are propelled by a steel cable (or rope) either in a jig-back or in a circulating mode. An electric engine moves the entire system at a steady and efficient speed.
Detachable ropeways are propelled by a revolving cable moving continuously in one sense. This form of common movement of many vehicles at a time is far more effective than the constant acceleration and deceleration of independent vehicles on rail or road networks.
Gondolas are attached to the cable when travelling between stations, and detached from it when entering and travelling through the stations. This allows the cabins to slow down in order to allow passengers to board and alight. Before leaving the stations they are attached to the cable again and accelerate out of the station.
Stations can be endpoints or intermediate stations. Intermediate stations may be 'travelling through' stations or joints between two different cables, permitting the separation of one line into two independent ones. At the endpoints, gondolas do a 180° turn and travel back to the other endpoint.

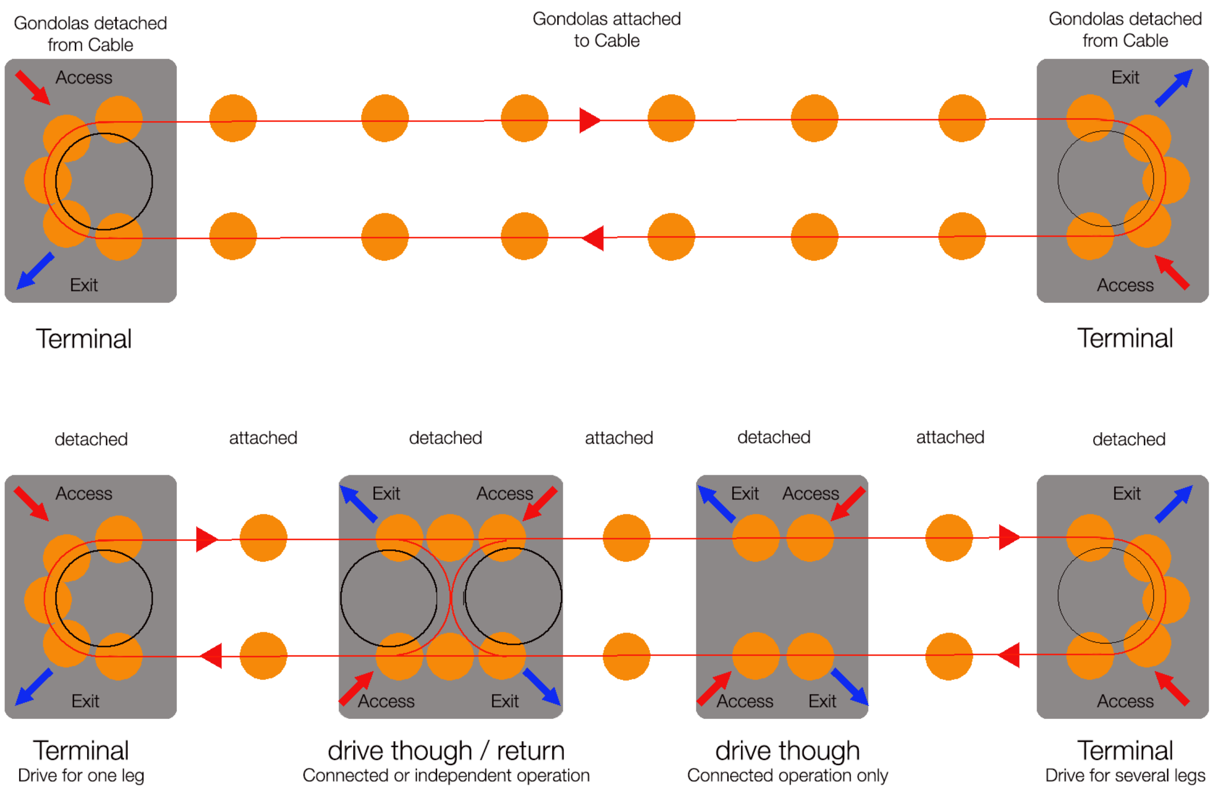

Image 6: Ropeways function; Matthias Nuessgen based on Raumkom, Urbane Seilbahnen, 2010

Gondolas can turn corners by automatically switching from one cable line (blue) to another in intermediary angle stations (orange circles).

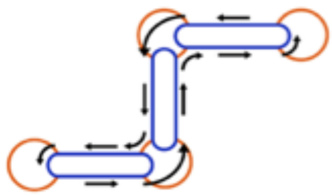

Image 7 :Turns;The Gondola Project, Steven Dale

Compared to other transport modes with similar capacities, gondolas have low maintenance and construction costs. The vehicles themselves do not carry engines, fuel or wheels, so they are of very low weight. Gondolas hardly suffer rolling resistance, which makes them a very energy-efficient and clean mode of transport.
With a maximum capacity of up to 6,000 pphpd (passengers per hour per direction), gondolas have a similar capacity as tramways or small to medium BRT systems, but they are far easier to integrate into an urban environment than a BRT system or an overground rail system.

3. Older generation ropeways

In Barcelona, there are three aerial ropeways with three very different characters. Each one of them seems to mark an interesting point in the history of ropeways in Europe. This is why Barcelona has been chosen as the first example.

The Transbordador del Port was planned in 1926 as a connection between the expo’29 and its maritime part in the harbour area. Due to missing private investors, the project failed to be finished on time for the expo and finally opened in 1931 after two years of construction time. Initially this ropeway was divided into two parts and users had to change cabins at the middle station 'Jaume I Tower'. There were four cabins, two for each part of the trip.
During the civil war the ropeway was closed and the cables were removed from the towers which were converted to strategic points for the defence of the harbour. In 1958, the company ‘Teleféricos de Barcelona SA’ took over the installations and reopened the service in the year 1963. Nowadays, the Transbordador has become something like a symbol for the Barcelona harbour and a big tourist attraction.
At the same time, it is one of the first ropeways carrying people instead of goods in an urban area and, to the authors' knowledge, it is the first one to be planned for a big event. So, in one way or another, it is one of the pioneer systems amongst urban ropeways.

The Teleférico de Montjuïc was inaugurated in 1970 to meet the requirements of an increased traffic to the top of Montjuïc hill. It complemented the already existing funicular and started to work as Line 15 of the official urban public transport operator TMB. It transported over half a million passengers per year, mainly tourists from the Montjuïc park to the castle on the top of the hill.
It ran daily in the sunny season of the year and only on weekends and official holidays in autumn and winter. At this point it was certainly one of the first systems to be completely integrated into the public transport network.
The ropeway was renewed between 2004 and 2007. Three modern stations were built in a common architectural style. The upper one is now located outside the castle.
After reopening, the ropeway it is still run by the TMB, but it does not form part of the regular public network any longer. It has a special fare, and does produce revenue for the Transport operator TMB.

The Olesa – Esparreguera Ropeway is another gondola in the Barcelona region, far away from the tourists and the buzz of the metropolis. It was only built in 2005 and was completely integrated into the public transport network until it was shut down due to economic reasons in the year 2011 and has not been working since then which makes a reopening more and more difficult due to the lack of maintenance.
It is a very small system with a capacity of only 180 passengers per hour connecting la Esparreguera with the metropolitan trains in the direction of Monserrat and Barcelona. The village did not possess any public transport connection to Barcelona up to this point, though it was only located one kilometre off the railway tracks on a Plateau.
Despite its small size, this system may well be the most interesting one in Barcelona for the purpose of this article, because it established a long awaited and demanded public transport connection, which immediately changed the lives of people in Esparreguera.
The bus connection that came to replace the cable car faces various obstacles like the crossing of a river, and a railway connection and takes 20 minutes for the trip, 10 times more than the ropeway.
While the other two systems in Barcelona serve purely touristic means, this one is a very good example for the difference a ropeway can make when it is used to bridge gaps in a public transport system.

Image 7 :Ropeways in Barcelona, a) Transbordador aeri, http://i.ytimg.com/; b) Teleferico de Montjuïc, cc Lolo42; c) Esparreguera, http://www.remontees-mecaniques.net/

4. New generation ropeways

The first new generation ropeway appeared in Medellín in the year 2004. It connects the densely populated neighbourhood of Santo Domingo Savio to the existing urban public transport network. Its completion was a revolutionary impulse to public transport in the city, that was now able to service the population of the mostly poor and heavily criminalised informal settlements surrounding the city. The first line K was quickly followed by the J line in Medellín and by the Metro Cable (San Agustín and Mariche) in Caracas, Venezuela.
Today both cities present the pinnacle of urban ropeways together with the cities of Constantine and Tlemcen in Algeria.
Very recent international examples are the systems of Algiers and the La Paz, Bolivia. The latter will soon form the largest existing comprehensive network of urban ropeway systems. It has ceased to only bridge gaps and is beginning to form of the backbone of public transport in La Paz and its twin-city El Alto.

New Generation ropeways are parts of a comprehensive transport system. They have capacities difficult to satisfy with a ground-based transport mode, apart from modes like BRT or light rail, which may have higher capacities but normally are a lot more expensive.
Ropeways have the ability to impact the character of the urban space surrounding them. In Latin America many houses underneath the ropeways are refurbished or decorated in a special way. The stations have been designed in order to work as neighbourhood centres and even cultural hubs. The ropeways create an identity for their neighbourhoods and their cities.

4.1. Koblenz

The case of Koblenz is a special one, because it was actually not thought to be a regular public transport mode, nor was there any thought in a longterm urban development option. However, the way it developed after its inauguration during the German horticultural show BUGA in 2011 is quite remarkable. Originally thought to be a temporary installation for the duration of three years, it still exists and will continue until at least 2026, because the population insisted. The urban development effect of the ropeway only became visible after the event was over.

Image 8: Koblenz cable car; Koblenz, Rheinseilbahn, Luftaufnahme.jpg Licence: CC BY-SA 3.0 Wolkenkratzer: https://de.wikipedia.org/wiki/Seilbahn_Koblenz#/media/File:Koblenz,_Rheinseilbahn,_Luftaufnahme.jpg

Having made the decision to host the show on two opposite sides of the River Rhine with the main site on a hill across the river opposite the city centre, the City of Koblenz immediately had to start thinking about the way to get the estimated 2 million visitors to the location. The two options were on the one hand an aerial ropeway over the River Rhine which would connect two of the locations directly to each other and on the other hand a shuttle bus line through the city. The decision for the ropeway seemed rather obvious regarding the following facts.

First, the travel time by bus would have been significantly longer than by cable car (4 min. vs. 25 min). Second, the number of passengers to be transported exceeded 10,000 p/day. This would have required running more than 100 busses daily through the inner city, over a bridge, up the serpentines of a step hill and back. So regarding the local situation, using a ropeway was an absolutely logical decision.

The Rhine Valley is part of the UNESCO cultural world heritage and there were a lot of voices proclaiming that the cable car would disturb the traditional image of the landscape and obstruct the views on a Roman basilica just next to the station.

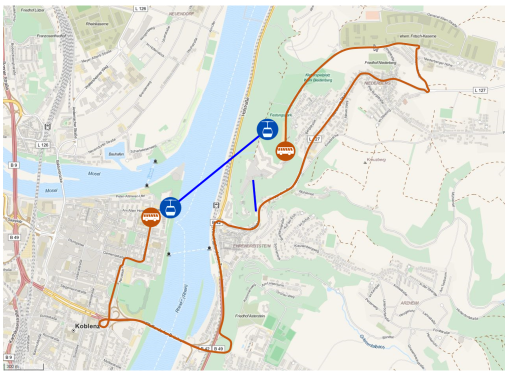

Image 9: Access - Buga, Open Street Maps, edited by Matthias Nuessgen

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In the absence of a viable alternative, a temporary permission was given by the UNESCO in 2008 to build a cable car over the River Rhine up to fortress Ehrenbreitstein and to the BUGA exhibition site and to operate it for three years. Afterwards, according to the exception made by the UNESCO committee, the system was meant to be dismantled. The manufacturer simultaneously was the investor and the operator of the system. The company would have disassembled the system and in the best case - reinstalled it at another location.

The cable car that was built in order to cope with the huge required capacity was the world´s most effective system at the time with a capacity of over 3,500 Passengers per hour per direction (pphpd), even at a reduced speed, permitting visitors to enjoy the enchanting view over the River Rhine and the city of Koblenz.

The 3S technology used here is the most advanced technology available in cable car transit. It uses 3 ropes, one for propulsion and two for support. It is very wind-stable and has theoretical capacities of 6,000 pphpd.
The system had a very successful test-run in 2010 and officially opened with the BUGA-exhibition in April 2011. During the six month of the exhibition, it transported 3.5 million passengers instead of the foreseen 2 million. Peak-days saw over 50,000 passengers use the Koblenz cable car.

Image 10: ·3S System in Koblenz; http://farm5.static.flickr.com/

Soon after the show, the first voices demanded the system should stay and be integrated into the city´s public transport system. Negotiations started in order to extend the operation of the cable car to beyond 2013. The city of Koblenz was very interested but the final decision depended again on the judgement of the UNESCO World Heritage Commission. The population of Koblenz was increasingly proud of their cable car and voted for an extended operation with over 90%. The only important critic was the Diocese of Trier, which was still concerned about the visibility of their Basilica St. Kastor.
Although rumours circulated about a negative judgement from the committee, UNESCO permitted the operation until the end of the technical operating period in the year 2026.
Besides the huge success as a mainly touristic transport mode, the cable car now started to clearly increase the region´s spatial and urban development options on the western side of the river. Some projects will most probably be initialised because of its existence.

Especially the redevelopment of the 'Fritsch Kaserne', a former military installation located north of fortress Ehrenbreitstein, could benefit hugely. Its conversion is one of the pressing needs of regional planning in the Koblenz area. The military site is for sale by the German government and has been included in a list of urgent planning tasks for the region. A master plan proposal for a mixed use development, combining residential use and services within the existing buildings, exists since 2008, but the search for investors is proving difficult.

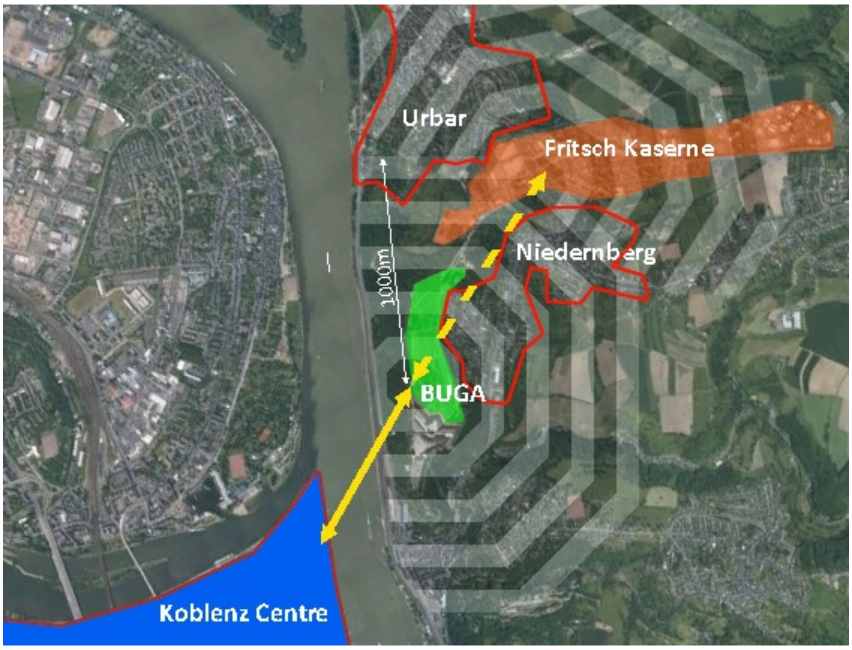


Image 11: Spatial influence; Matthias Nuessgen, 2014

In a new commercial dossier on redevelopment sites in the area, the ropeway is named as a main quality for the location. It offers a quick and comfortable link from the project site to the city centre in about 10 minutes. A trip which would take 30 minutes or more by car. Lately, even an extension of the cable car directly to the development site has been discussed. This would obviously include improved transport options for the neighbouring villages Urbar and Niederberg which could be easily connected to the ropeway and Koblenz city centre.
Obviously an extension system would only need to satisfy a much smaller demand, so the operation would generate clearly lower construction and maintenance costs than the original crossing of the River Rhine.
Even including potential users from the two neighbouring villages, demand would not exceed 500 pphpd. Systems in this range with a length of around 1 km would probably be available at a price that an investor could find worth considering in order to add to the attractiveness of a development.

The most pressing task, however, from an integrated planning point of view would now be the full integration of the cable car into the public transport system of the Koblenz area, which is still due, and would surely provide another valuable impulse to the new development options.
In order to distinguish between fares for tourists and regular users, the round trip could be clearly more expensive, whereas monthly or even annual passes could be fully integrated into the public transport fare system.

4.2. London

The London Docklands may well be one of the biggest coherent urban redevelopment areas of the world. There are some success stories, like Canary Wharf, which was converted from a dying harbour area to one of the world's leading commercial centres within 20 years. Nevertheless, there are other areas whose development was rather hesitant. Two of these sites have now been connected by the Emirates Airline, a ropeway connection operated by London's public transport operator 'Transport for London' (TfL).

Greenwich Peninsula

Greenwich Peninsula was one of London's biggest industrial sites. From the 19th century onwards, the area was dominated by the East Greenwich Gasworks for over a hundred years.
During this period of industrial use, Blackwell Tunnel was built as a part of a road connection from The County of Kent to London in order to improve commerce and trade in the London East End. Until 1999 this tunnel was the only useable connection from the peninsula to central London, so that from a public transport point of view the peninsula stayed very remote until the end of the 20th century.

Image 12: Greenwich Peninsula 1999; http://charltonchampion.files.wordpress.com/

After the decay of the heavy industries and the beginning of the postindustrial transformation in the harbour, a first phase of urban redevelopment brought substantial changes to the peninsula and to all of East London. In the 90s, development agencies started to buy land on the peninsula. The Construction of the Millennium Dome was to initiate the beginning of another redevelopment success story. Though the Dome attracted immediate international attention to the peninsula, a comprehensive redevelopment process never really started.
The only project launched was Greenwich Millennium Village (GMV), which was considered an alternative proposal to the traditional residential developments, putting emphasis on public spaces, green zones, eco-friendly buildings, non-motorised transport infrastructure and community zones.
From a transport point of view this period saw some significant improvements. The most important one was without any doubt the opening of North Greenwich station on Jubilee Line, the first tube station in the history of the peninsula.

The development of the peninsula progressed further, when in 2002 a master plan of the north-eastern part of the Greenwich Peninsula was published. However, all these development initiatives came to a halt shortly after they started.
Until the Olympics came into sight almost 10 years later, there was no coherent vision for the Greenwich Peninsula that would have included it in the successful planning history of Canary Wharf and the likes in the East London Docklands.

Royal Docks

Completed between 1855 and the 1920s, the Royal Docks gave a whole new commercial perspective to the London Harbour. They were designed as a harbour for ships too big to be accommodated further up the river and, thereby, became a huge commercial success in their time.
A steady decay from the 1960s onwards made a potential fourth dock obsolete. Instead, a period of degeneration began, both for the built infrastructure and facilities, and for the workers of Silvertown and North Woolwich, the stretch of land between the river and the docks. It became an area with pressing social problems.

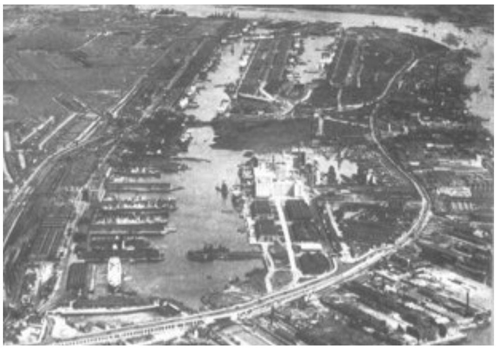


Image 13: Historical photo of the Royal Docks; www.abandonedcommunities.co.uk/

After the closure of the Royal Docks in 1981 the first phase of redevelopment was the London City Airport, which on the one hand increased the attractiveness of the new commercial development in Canary Wharf, but on the other hand made residential redevelopment on the Royal Docks even more difficult.
Later, the ExCel exhibition centre north of the Royal Victoria Dock took advantage of the airport and a residential redevelopment called Britannia Village was built south of it.
This residential development meant to have a second phase called Silvertown Quays, which was proposed in the year 2001. However, there was no progress until 2010, when the contracts with the - completely inactive - development company were finally cancelled. The area was then integrated into a larger master plan for the Royal Docks, including housing for over 30,000 people and a third business and financial centre for London on Royal Albert Dock, just opposite the London City Airport.

Connections

One of the main criteria for the difficulties in the eastern development areas of the London Docklands were the scarce public transport connections and river crossings.
Until the completion of the Emirates Airline, the Tower Bridge was the easternmost overground river crossing in London. In the Docklands there were only the underground connections of Greenwich tunnel between Greenwich Peninsula and the Isle of Dogs and Blackwell Tunnel.
The need of a new East London river crossing was being extensively discussed and evaluated, when in 2010 Transport for London proposed a cable car link between the Royal Docks and Greenwich Peninsula.

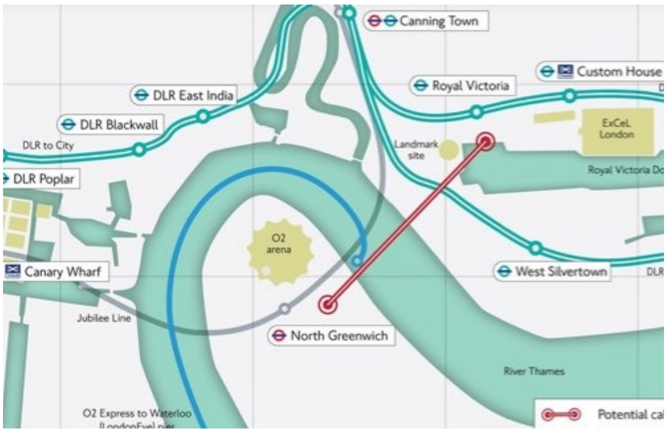


Image 14: TFL Proposal; http://www.abandonedcommunities.co.uk/

Olympics

The reason for the increased necessity of a new crossing was the upcoming mega-event of the 2012 Summer Olympics, taking place in East London, using sites in the eastern Docklands.
At this point, a long-awaited common development initiative started. From a transport perspective, the connection problem became unbearable, and it became clear that there was a need for a direct overground transport link between the venues in the northeast and those in the southeast.
Following the initial proposal in early 2010, Transport for London announced the planning of a cable car service from Royal Victoria Dock to the northern part of Greenwich Peninsula in late 2010.

In the short term, the system would serve as the missing link between the East London Olympic venues. It was planned and implemented very quickly and apart from its value for the public transport system, it provided a stunning travel experience. With over 380,000 trips in the 16-day period of the Olympic Games, it became one of the main attractions of the Olympics.
In the first year of its existence, boosted by the huge visitor-numbers of the Olympics and Paralympics, the 'Airline' transported over 2.4 million passengers. Many thought this was only a temporary boom, but the numbers of the second year show that even without huge events, the airline was used by over 1.4 million passengers.

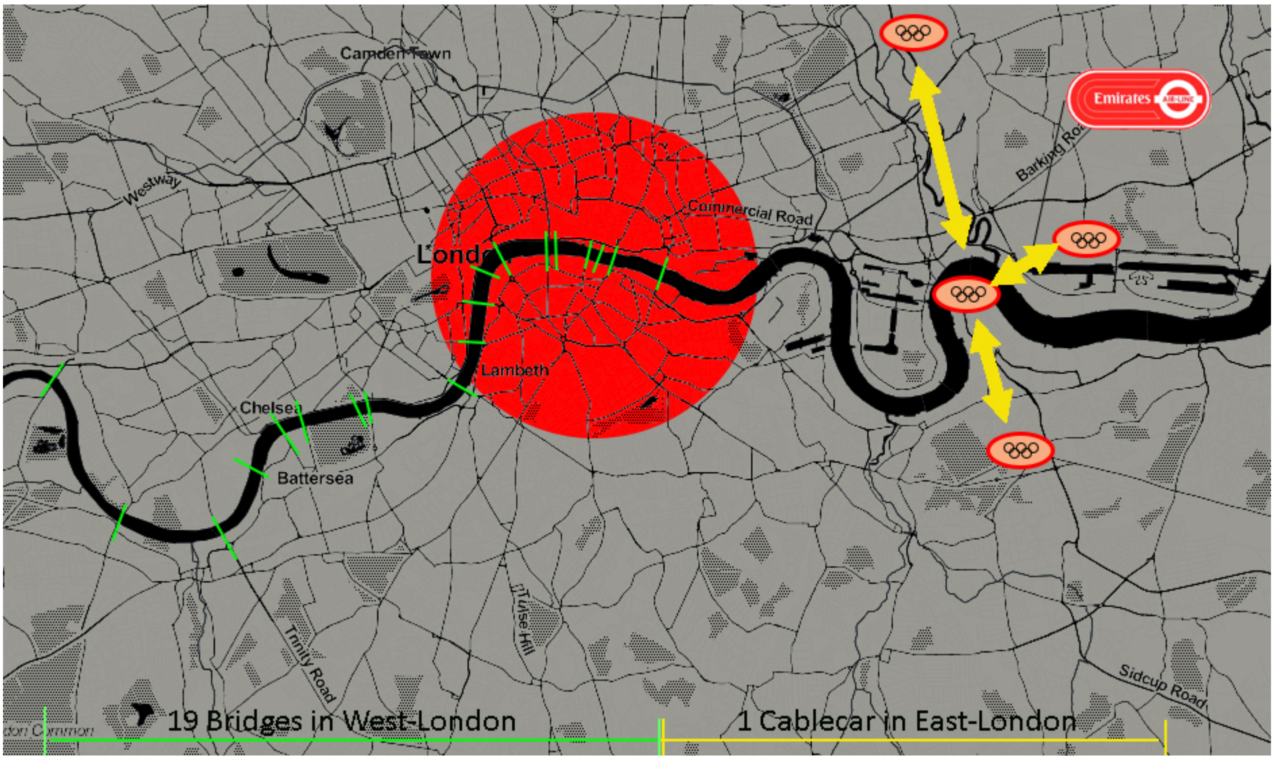


Image 15: River crossings and connections; M. Nuessgen based on www. mapstack.com

<u>*The cable car in the big picture*</u>

These numbers are about to increase again, because in the long term the 'Airline' establishes the missing link between two mayor urban development sites situated just opposite each other. Until the inauguration of the cable car connection, both places were still voids and were experiencing serious problems in starting a coherent redevelopment, but both seem to be moving forward now and will be exciting new parts of London.
On the Greenwich Peninsula, building activities for at least two new mixed-use developments have already begun and two more are finalising their master-planning with world-renowned planning offices, ensuring a high quality of public space.
On the other side of the river, the coherent master plan of the Royal Docks has been published and building activities are due to start. The cable car has now united these two separated developments in a very efficient and passenger-friendly way.

<u>*An extension of walking space*</u>

Gondolas are much easier to use than most other public transport modes. Because there is practically no waiting time, gondolas resemble walking in the continuity of movement. Additionally, the user is presented a stunning view of the city, comparable to the experience of crossing a bridge on foot. This is the reason why many planners refer to cable cars as the extension of walking space.
As such, it has brought the O2 Arena and the ExCel, London's biggest event location and biggest exhibition centre, respectively, within 'walking distance' to one another, by directly connecting two of the most interesting urban developments in London.
Access to the stations is much easier and they are much more integrated into the public space than underground public transport solutions. 'The Airline' increases the attractiveness of both sides and will be a regularly used link between them.

The local effects

Image 16: London City Beach; http://www.newhamrecorder.co.uk/

After two years of operation, the initial effects are already visible. In the direct surroundings of the cable car, a number of small changes towards a liveable urban space are taking place.
London City Beach has opened at the western tip of the Victoria Dock, beach bars and cafés are opening and forming a new, lively and friendly atmosphere. Water sports activities are initiated on the huge water basins of the docks, and street vendors find their customers in the growing number of visitors.

Influence on the planning process

Images 17, 18: The floating village; http://www.royaldocks.london/

As the master-planning took place with the 'Airline' already operating and some of the small, local changes already in place, it seems highly probable that planning was inspired by the existence of the cable car and its initial effects. Some of them seem to have made their way into the official Royal Docks Master Plan. The idea of the village on the water with floating houses on the Royal Victoria Dock fits seamlessly into the character already to be found beneath the cable car.
It would not be the first case in which developers scent a certain character of an existing temporary use on an urban development site and try to conserve this character in the final planning.

4.3. Bolzano / Bozen

Image 19: Front-view station; http://gondolaproject.com/wp-content/

Image 20: view from above; www.remontees-mecaniques.net/

The Rittnerbahn in Bozen cannot entirely be considered an urban transport solution, but it is definitely not only a tourist attraction either.

It connects the city of Bozen with Oberbozen on the Ritten, which originally was a small mountain village depending on Bozen and has now developed into a mountain resort. The cable car is directly connected to the train station in Bozen and has become the main transport mode for trips between the two places.

The Rittnerbahn may not be the most significant example for the benefits that a well-functioning urban cable car can produce for city development, like in London or Koblenz, but it surely is an excellent example for the seamless integration of a station building into an existing city structure.

Seen from the front, one would rather not expect the building to be a public transport station. It offers a variety of public shops, such as a bakery and a café, in its spacious and publicly accessible ground floor. The upper floors are only accessible with a ticket. The access to the cable car itself works via stairs, but there are two elevators making the station completely barrier free.

Outside the station, there are extensive bicycle parking facilities. The station is also connected to a covered car park and located directly opposite the Bozen train station.

In the field of operations, however, some harsh planning deficits are pointed out in a report by Steven Dale on *http://gondolaproject.com*. In his report, he analyses the huge difference between the system's theoretical capacity and the real demand.

On the one hand, the technically very advanced 3S system would theoretically be able to transport clearly in excess of 4000 passengers per hour per direction (pphpd). On the other hand, the system's real capacity is only about 550 pphpd, because it uses less than half the gondolas it theoretically could.

So, in the first place the question is why the 3S model was chosen for a system with a demand which could easily be satisfied with a smaller and obviously much cheaper system. The use of the 3S model with the reduction of its capacity seems to result in further functional issues. The reduction of gondolas, for instance, reduces the number of seats passing though the station and makes for waiting times of between 30 and 40 minutes in high season.

Cable car specialist Steven Dale is convinced that these waiting times could be almost eliminated only by doubling the number of gondolas, although even at this increased rate of 1100 pphpd it would not nearly be necessary to use the expensive 3S system to satisfy the real demand. At the capacity levels necessary to operate the system in Bozen, a much cheaper system should be able to work better (in terms of waiting times) than the one that has actually been installed.

Hence, in this case a near perfect urban integration does certainly not show the whole picture, because the cable car, so beautifully integrated, was not properly adapted to its real demand.

Image 21: Surroundings; www.gondolaproject.com/

5. Projected systems and visions

5.1. Hamburg

Hamburg is one of the fastest growing cities in Germany, with a projected yearly need for around 6000 new housing units. Historically, Hamburg has always been an independent city-state, which gives it the administrative level of a federal state, but also limits development space, which is a significant problem for a growing city.

The island in the centre

The city of Hamburg has three main parts:

- Part 1: The inner city, with all the main city functions, north of the river.
- Part 2: The Island of Wilhelmsburg formed by the Elbe is partly harbour area and partly residential.
- Part 3: Harburg in the south of Wilhelmsburg Island is mainly residential, though also the location of one of the two big universities of the city.

Wilhelmsburg Island presents considerable problems to the city. It has significant potential for urban development, but is at the same time limited by its geographical location and the harbour.
It has been one of the city's main urban development goals for a long time to reanimate the development on the island and to the south of the island, but this never actually happened.

Image 22: The Island in the centre; http://www.hamburg.de/

Image 23: 3 parts; M. Nuessgen based on www.mapstack.com

The harbour

Hamburg has one of the most important harbours in the northern part of Europe. Big parts of Wilhelmsburg Island are still used as active parts of the harbour-economy.
Some of them are located just opposite downtown Hamburg, forming an east-west barrier between the north and the south of Hamburg, which is very hard to overcome. The harbour lies in the middle of the city like a wedge.
It is becoming clear that it will not be enough to initiate interesting and attractive development projects in the southern part of the city, as long as they are missing a direct, inner-city connection across the harbour.
At the moment, the harbour is still one of the most important economic factors for Hamburg, but the city's growth and the need for urban redevelopment are clearly gaining importance.

Image 24: Hamburg Harbor; www.hamburg.citysam.de

From London, Rotterdam, Antwerp and other harbours we know that the development of a harbour is mostly oriented towards the sea in order to be able to berth bigger vessels.
Inner-city industrial or harbour-sites have been abandoned in many places during the last decades. Their location did not longer allow an economically effective operation and they would hinder inner-city redevelopment.
Hamburg is most probably not going to be an exception to this trend. The commercially most interesting parts of Hamburg´s harbour are the container terminals west of the city, while the inner-city sites are expected to have only a limited future as essential parts of the harbour economy.

Image 25: Hafen City; HafenCity Hamburg GmbH

From an urban development standpoint, the growing attractiveness of inner-city waterfront development sites has been proven in numerous cases in Europe and internationally.
Hamburg has various sites with these characteristics, and one day - following the rules of economy - they will become more attractive as redevelopment sites than as functional parts of the harbour.
One of them, the HafenCity on the north shore of the harbour, has already been redeveloped and is about to finish its construction activity in the near future.
There are a lot more of these sites to be found in the south of the city, but they are still lacking a powerful public transport connection, and they are subject to a special harbour law, which the city has developed in order to defend the functionality of the harbour economy.

Subtle changes
One of these potentially attractive redevelopment sites is Steinwerder. It is a part of the harbour, located directly opposite the famous HafenCity.
A different kind of development is starting to take place here already. A waterfront-site is rented out to an entertainment company, which is operating two musical theatres there. In addition to that, the construction of a new cruise ship terminal will be completed in summer 2015.

Image 26: Olympic Park project; Gerkan, Marg & Partner

At the moment, any further urban development, generated by these initial changes, is still stifled by the harbour law. Nevertheless, to the author´s eyes, the area is changing already and is expected to continue doing so at an even increased pace. On a public website with visions for Hamburg´s future, one can already find interesting ideas to incorporate that area into the city.
In the pursuit to host the Summer Olympics in 2024 or 2028, the area 'Kleiner Grasbrook' west of Steinwerder has been designated as the location of the Olympic park.

The idea
The operator of the above-mentioned musical theatres, together with a cable car manufacturer, was offering the city of Hamburg to build a very efficient cable car system from St. Pauli to Steinwerder.
It is obvious that they were first and foremost looking for an alternative way to bring visitors to the theatres.
In the beginning, the initiators offered to take the cable car farther south to establish a connection to the south of the Wilhelmsburg Island.

Image 27: Station St. Pauli; http://www.hamburger-seilbahn.de/

Discussion and decision

The city of Hamburg suddenly had the opportunity to to make an area accessible which most certainly will be an interesting future urban redevelopment site, without spending any public money. The offer included the construction and the operation of the system over a period of ten years. After that, the system would have been either dismantled or sold to the city for further operation.

The discussion about the project went on for a long time, and the project was finally rejected by a citizen vote on the 26th of August 2014. However, the citizen vote did not ask all of Hamburg's citizens. Due to the administrative system, only about 200,000 inhabitants of the Mitte area, where the cable car was to be installed and where the fears and doubts were obviously most accentuated, were allowed to participate in the referendum.

The district council had made its opposing position very clear from the beginning, and thus a decision pro cable car was not very probable, despite a citizen initiative which fought through various administrative barriers in order to achieve a public vote against the political will.

Image 28: View from St. Pauli to Steinwerder; http://www.hamburger-seilbahn.de/

Opponents of the project considered the ropeway a tourism project with minimal benefit to the city. They were concerned about the effects the ropeway pillars would have on the traditional silhouette of the harbour and about the overload of tourists flooding St. Pauli, which is already the most touristic area in Hamburg.

These arguments started to become credible when one part of the proposed corridor, the connection to Wilhelmsburg, was abandoned and only the river crossing from St. Pauli to the theatres remained.

Other groups viewed the project in a rather pragmatic manner. For them, the benefits for the city of Hamburg did exist: they saw the ropeway as a highly attractive connection across the harbour at no cost for the public budget. They considered the towers could become attractive and positively connoted landmarks. Especially in a harbour area dominated by high vertical structures like cranes, masts etc. it was surprising to them that the thoroughly designed towers of a cable car should have such a devastating effect on the silhouette. They further argued that in the long run it was rather probable that the ropeway would help to distribute the tourists and that it would initiate the creation of better connections, once it was fully integrated into the city's public transport system. They expected the ropeway to establish the first and most important step of the long-awaited leap across the river.

Following the discussion about cable cars in Europe, the case of Hamburg displays a typical dilemma, which often occurs if there is no political will behind a project involving an innovative technology.

In order to implement such a technology, it is almost always necessary to convince an opposing majority of citizens who tend to be rather conservative in the beginning. This is very difficult to do against a solidly pronounced political will, like in Hamburg. Expert opinions are unlikely to change this, because politics are not exclusively oriented towards public benefits, but also often need to take into account a wide variety of other, more particular interests.

In Hamburg, the pro-ropeway citizen initiative has come a long way, even achieving a citizen vote against the political will, supported by several expert groups and urban planners. In the end, however, it failed to convince politicians and the public.
The City of Hamburg is still in need of a direct connection across the harbour, and it will be interesting to see how it will solve this pressing problem.
In a very recent talk-show about the cable car discussion in Hamburg, Heiner Monheim, a well-known German transport planner and professor, stated that he would even think about an extension of the ropeway system to the Hamburg Exhibition Centre farther in the north.
In this case, the cable car would establish a first north-south axis of public transport in Hamburg, finally making the Wilhelmsburg Island accessible in less than 20 minutes from the city centre.

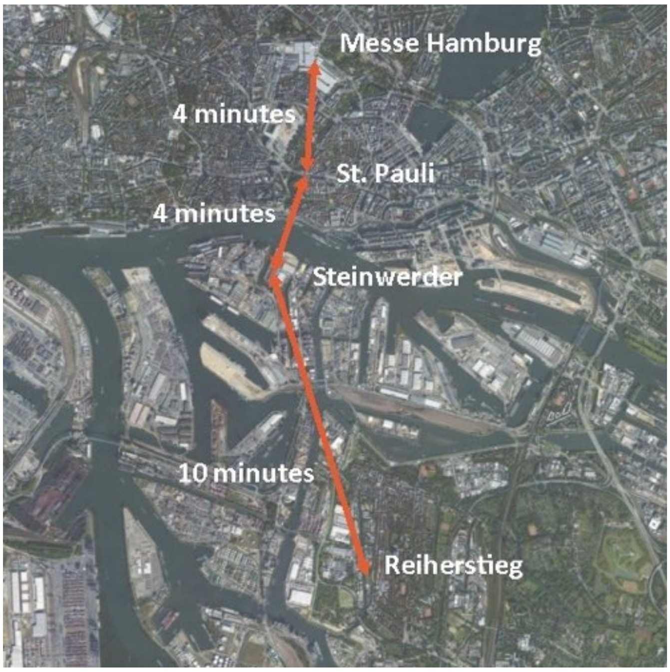


Image 29: Extension to the North? M. Nuessgen based on Google Maps

Image 30: View downstream; http://www.hamburger-seilbahn.de/

5.2. Brest

Brest in France will open an urban gondola system in 2016, crossing the River Penfeld from the city centre to the Plateau de Capucins, where a new urban development area is starting to be implemented.

Image 31: Impression; Image: www.septjoursabrest.fr

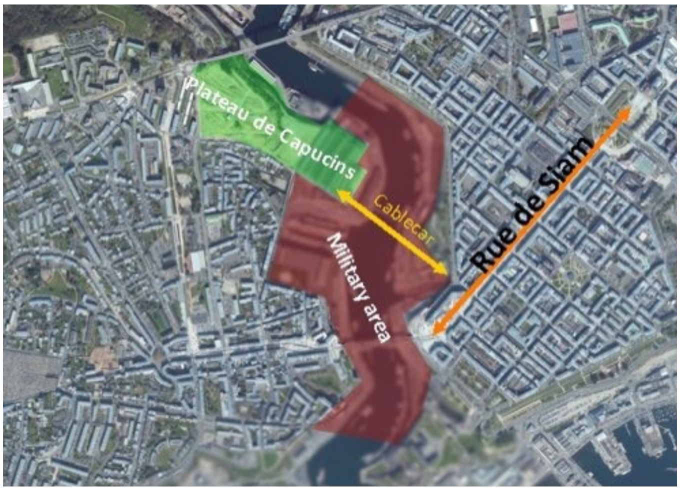


Image 32: Project overview; Image: M. Nuessgen based on Mac Maps

The system will be fully integrated into the city's public transport system. It has two stations and only a length of approximately 410 meters, but has to be high enough to allow ships to pass underneath. The cost is estimated at approximately 19 million euros.
The cable car ends in a new urban development, which reuses the former storage buildings on the Plateau des Capucins as the location for a new commercial and cultural centre. The entrance to the cable car on the opposite side of the river will function just like any other entrance to the new centre. It is located at the end of Rue Siam, the main arterial street in Brest and one of its commercial centres, about 100 m away from a tramway stop.
It is possible that this new access from the other side of the river might have been a prerequisite for the economic viability of the commercial centre, whose accessibility would be rather limited without it.

The commercial centre will be the heart of a new mixed-use development project, on the bank of the Penfeld River just opposite the city centre. Car trips from the new development to the city centre will be far less convenient than trips by cable car. There is potential demand for a direct connection on both sides.

The ropeway will use a new type of pendular system with a vertical crossing. The administration refers to considerations of urban design to justify this decision, rather than to the significant technical differences between this design and alternative urban ropeways. It remains to be seen how the innovative design performs in reality.

Image 33: Vehicle design; www.capucinsbrest.com/

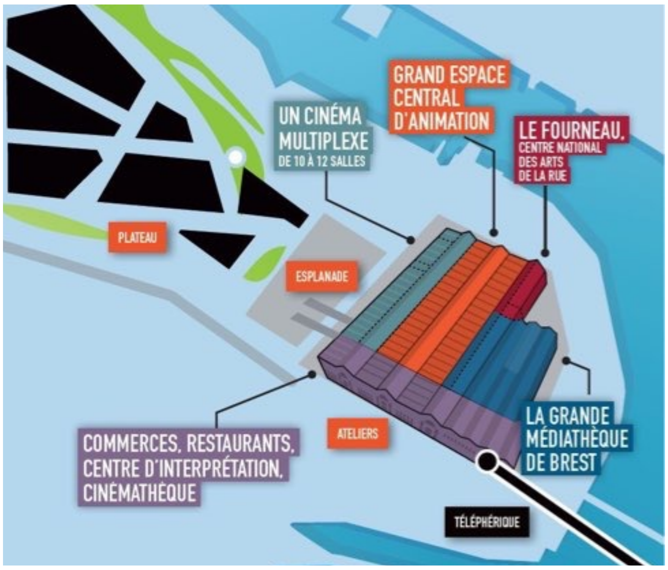
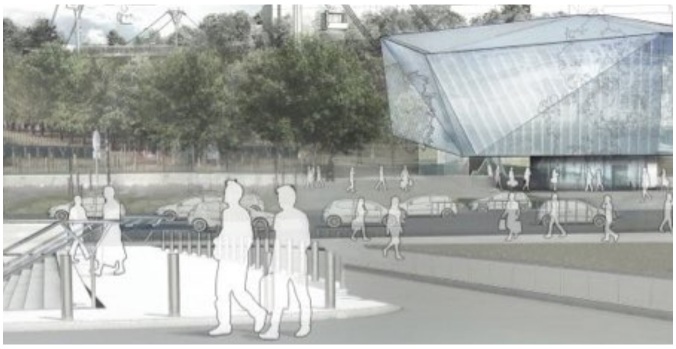


Image 34: Project overview; www.gondolaproject.com/wp-content/

5.3. Toulouse

Images 35, 36: Impressions stations Toulouse; http://france3-regions.francetvinfo.fr/

In Toulouse, a new urban 3S gondola is planned to connect the new cancer science cluster Oncopole to the Hospital of Rangueil and the University faculties of medicine and pharmacy in 2017.
The project is still registered in the urban development plan, but it is facing a strong political headwind because of its high costs.
Instead of the original 45 million €, the project is calculated at 63 million € at the moment, and it will most probably rise to about 80 million €, which is considered too expensive for an estimated total of 7,000 trips daily.
Even if this system is not going to be built in the end, it is still interesting to take a closer look at the project, which might be the first 3S gondola system completely integrated into an urban transport system.

The following plans and figures will document very well the indisputable planning logic behind the original project. The three stations correspond to three poles of health activities within Toulouse, which are separated by the River Garonne.
The Oncopole is a newly developed science cluster in cancer research. By 2020, it will house a cancer hospital with over 1,750 employees and the actual science centre with over 5,000 employees.
In Rangueil, there are two hospitals with about 3500 employees in total. This number is expected to increase to 4,000 employees by 2020. Additionally, there is a small residential development with a population of about 1,750, which is expected to grow to about 3,700 by 2020.
The University of Paul Sabatier has over 27,000 students and about 4,000 teachers and scientists.
The cable car would shorten the trip from the University to the new Oncopole, from about 35 minutes by bus to ten minutes by cable car.

Image 37: Project overview Toulouse; http://img823.imageshack.us/

A direct connection between these three poles is completely logical, especially if one takes into account the potential urban development that could be initiated by the appearance of a new science centre of this size. It will most probably attract residential and commercial development in its neighbourhood, even more so if it possesses a direct link to a transport hub with various bus lines and a metro station at the University.

Extension?

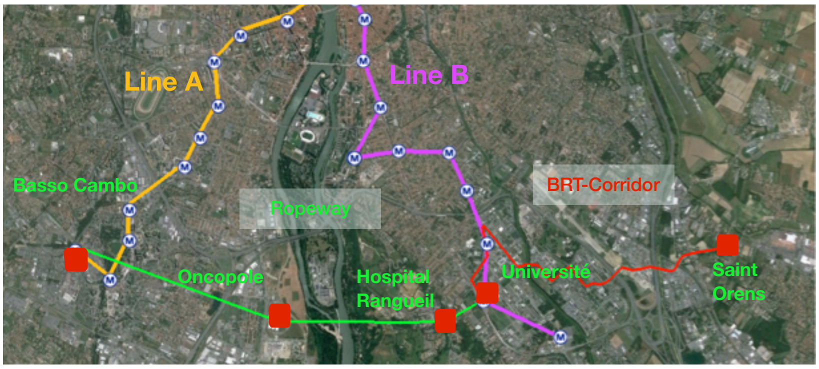


Image 38: Traversal corridor and extension M. Nuessgen based on Google Maps

In summer 2014 it appeared as if this original project - as logical as it had seemed - was almost certain to be abandoned for financial reasons. As a consequence, it has now been reassessed, and surprisingly the result was exactly the opposite of what seemed to happen in 2014. Now an extension of the project is being discussed. It could be extended to the east in order to meet the metro line A in Basso Cambo, which is another important transport hub in the south of Toulouse.
The cable car would connect the two metro lines and link to the newly created BRT corridor 'Liaison Multimodale Sud Est' (LSME) in the south-east of Toulouse ending in Saint Orens. This combined transversal corridor would certainly increase the low expected ridership dramatically and possibly make the project financially viable.

System

Even though the ridership is going to increase with the extension to Basso Cambo, the system choice is worth a closer look. The originally envisioned 3S technology is the most advanced technology available in cable car transit. Its main advantages are its high wind-stability, its capacity of up to 6,000 pphpd and its higher operating speeds.
These advantages obviously come at a price clearly more expensive than any other cable car system with a smaller capacity. The system in Toulouse was meant to be such a 3S system, but working at a very low capacity with only 750 pphpd. This said, it is necessary to mention, that even this reduced capacity would be four times higher than the expected total demand of 7,000 passengers per day in both directions. A smaller and considerably cheaper system would have been more than enough to meet the actual transport needs of the original project and may still be worth considering even with a clearly increased ridership expectation.

Station architecture

The design of the stations and their integration into the urban fabric are hugely important to the functionality of transport modes in general. Nevertheless, they need to be adapted to the budget, exactly like the design of the systems themselves. In the case of Toulouse, the budget appears to be rather limited.
Ropeways in Latin-American countries often have station designs that are as important to the entire project as the system itself, because they bring new and necessary urban functions into the respective neighbourhoods. It is assumed that their cost will make up a major part of the entire project budget. In Europe, apart from the financial viability of the project, often the design and the integration of the ropeway system into the urban structure are considered rather more important than the stations. It is possible to build lean and functional ropeway stations at a reasonable cost and still have them look elegant.
In absence of more detailed information on the financial background of the planning process in Toulouse, it is difficult to judge, but it still seems reasonable to guess that the station design and the construction cost may have contributed to the increase of the overall cost. Still, it would seem contorted if the exaggerated cost of an over-dimensioned system and the architecture of the stations led to the abolition of a well-conceived and logical project with a huge potential for the development of the city.

6. Conclusion

Ropeways have become comfortable, high-capacity public transport systems. They are able to create direct links where other modes require long detours or massive infrastructure. They are attractive for both commuters and tourists because they offer a better travel experience than any other public transport mode.
Cable cars offer unique opportunities to provide direct transport links crossing physical barriers. In some cases it can even be urban fabric or the traffic on the ground that constitutes these barriers.
Ropeways slowly leave their niche existence, and we are starting to see them working in completely flat settings, without bridging any natural barrier, because they have other benefits in terms of speed, capacity, cost, implementation time and the independence of urban fabric and traffic on the ground.

The objective of this article is not the promotion of one public transport mode against another, but rather the analysis of the special potential for urban development that ropeways may offer within a seamless, comfortable, affordable and fast public transport system.

For the users, the main purpose of public transport is the accessibility it offers. For a city, there is more to it. There are various direct and indirect ways in which transport systems, especially ropeways, are able to influence urban development.

Cities need public transport because it is the only way for them to free themselves from their decades-old automobile dependency. For this to be possible, however, public transport needs to be considered an alternative to the car by the steadily growing number of users.
The typical commuter in a metropolitan area does not think of the negative effects of automobile traffic when he starts his car trip parallel to the rails of the metropolitan train. Had he taken the train, maybe he would even have arrived at his office earlier. He even knows that, but he still uses the car because of its convenience as a private space. When it comes to personal decisions, there is usually no consciousness of the overall effects.
At the same time, the cyclist in Copenhagen does not think of global warming either and still uses his bicycle to commute to work, just because it is the most convenient way for him to get there.
Convenience is what really makes the difference in personal mobility decisions in postindustrial Europe. Ropeways offer a very convenient, even pleasant trip experience and a continuous mode of transportation, with a cabin departing every few seconds. They are absolutely independent from traffic congestion on the ground and, most importantly, the safest transport mode known to date.

Transit-oriented developments all over the world show that public transport and even non-motorised transport have the ability to replace the car as the daily means of transport if only they are convenient enough.
If they achieve this, these alternative transport modes will be able to fuel development projects, using a new planning paradigm.
An urban planning paradigm based on proximity does not generate trips which are conveniently made by car. It generates trips which can be made faster on foot, by bicycle or by using direct public transport links, like the urban cable cars. These links then expand the distance that a person is willing to cover without using a car.
Such a proximity paradigm would return the human scale to the cities. It would make urban space more comprehensible, more usable and more liveable.
In many cities around the world, the centres have developed this human scale without any planning effort behind it. They often measure about one square kilometre. So crossing these centres is a convenient trip, even if it is done walking. In general, for such a trip the use of a car does not offer enough advantages.
For these reasons, 500 to 1,000 metres is the distance on the basis of which we should distribute urban functions. It should be the maximum distance to reach the next pocket centre in a multi-centric city. In order to move from centre to centre or from the centres to the transport hubs, this distance can be extended by direct transport links that need as few transfers as possible and offer a comfortable, fast and pleasant travel experience for everybody. Cable cars are an ideal mode for this purpose.

A main operating field for the cable cars of today are feeder systems. These are not direct links to a city centre, but to a mass transit system. They help the mass transit modes to enlarge the corridor of city fabric they are able to cover and make them use their capacity more effectively. This increases the attractiveness of public transport, for the user as well as for the operator!

Most of the time, the physical limits for city development are evident. They have been basically the same as long as there has been conscious urban planning. Many of them are geographical limits, like rivers, mountains, height differences and the likes. But every once in a while, an innovation in transport has been able to move these limits, like the train, the car, the underground metro or BRT systems, especially in cities in developing countries. The author is convinced that cable cars are another one of these revolutionary transport modes with the potential to move the limits of city development. The most revolutionary aspect, however, is that cable cars will not move the limits towards the outside of the city, like mass transit or individual motorised transport have done for so long. The next movement has to be towards the inside. Internal development means that we have to manage density by reclaiming the urban space from traffic and reducing trip distances.

Cable cars are amongst the cleanest, quietest and most efficient transport modes in terms of energy and urban space. This makes them work well even in the densest neighbourhoods.
Their stations are big structures, but architects are learning to make them as lean as possible and to give them additional functions in order to integrate them seamlessly into the urban fabric.

Lately, cable cars even appear to become fashionable. They seem to be conceived as the transport mode of the future. That is good news, as long as the decisions to build them are not affected too much by fashion.
If planners continue to develop cities towards their inside and to make them accessible and liveable, cable cars will have their place in urban transport all over the world, and certainly in Europe.

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Images:

Image sources are to be found directly underneath the images and as links in digital versions.

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Most cities or regions receiving international assistance to make their transport systems more sustainable are often focused on technological solutions and do not have a holistic long-term policy on how a change in their mobility systems can be achieved. Investments in technological solutions have little impact in the big picture since transport systems in many regions of the world are not ready to apply them. It must also be assumed that efficiency gains from improved technologies will be cancelled out by the increasing number of motor vehicles and the growth in freight worldwide.

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Eurist
European Institute for Sustainable Transport
Weidenbaumsweg 13
21029 Hamburg

info@eurist.info
+49 40 5327 8740