The Tramway, aka LRT

An efficient, esthetic, durable mass transport resource

for medium-sized cities

Marc le Tourneur
(former director of the Montpellier Public Transport Company)
France

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SUMMARY

1. The tram, a transport mode between BRT and metro

2. The tram (re)birth in France, a success story
   - France: Public Transport organization
   - 28 new tram networks in 30 years
   - New trams, a revolution for Public Transport
   - Three causes for the tram success

3. The case of Montpellier: an exemple of a successful choice for tram
   - A rapidly growing city in Europe
   - Sustainable mobility: a global approach
   - Strong ties between city planning and Public Transport
   - Paid parking: first step in congestion charge
   - Pedestrian only zone in all historical center
   - The creation of a 4 tram lines network in 15 years
   - Integrated and intermodal Public Transport network

4. The Tramway/bus/BRT compared economic analysis in Montpellier

ANNEXES

1-Urban growth and public transport development
2-Tram line description
3-Figures
4-The case of Strasbourg
5-Examples of European trams
1. THE TRAMWAY BETWEEN BRT AND METRO

In the world's major cities, mass transport comes down to a choice between metro (Mass Rapid Transit) and BRT (Bus Rapid Transit).

The tramway, whose revival dates from only the 1980s, appears as a mode of transport that is:

- **Touristy and historic** for the cities that have kept their old tramways (San Francisco, Rio de Janeiro, New Orleans, etc.)
- **Esthetic and costly** for the new tramways built generally in the richest countries

![New York's subway](image)
![Bogota's TransMilenio](image)
![Rio de Janeiro's Bonde de Santa Teresa](image)
The **modern tramway** (or Light Rail, or VLT, or light metro) holds its place between the BRT and the metro.

**The capacity of the vehicles** places the tram between buses and metros:

- **articulated bus**: 105 places (18m long) to 150 places (24m long)
- **tramway**: 200 places (30m long) to 350 places (45m long)
- **metro**: 300 to 1500 places, depending on the length of the trains.

**The total investment cost per kilometer** for a complete line also places the tram between BRT and metro:

- **BRT with new infrastructure**: €5 to 15 M/km
- **tramway**: €15 to 40 M/km
- **metro**: €80 to 200 M/km.

**The operating cost per kilometer traveled** within the same country places the tramway between bus and metro.
LRT, a large capacity mass transport resource

Istanbul
260,000 daily passengers
60 meters long
450 places

Montpellier
130,000 daily passengers
40 meters long
300 places
Tram length can be increased progressively. The higher the capacity is the cheaper the system is per passenger.
In the countries of the OECD, the passenger transported in a tramway often costs less than in a BRT over the lifetime of the system.

- **The total investment cost** (infrastructures and vehicle) is **2 to 3 times higher**.

- But **the operating savings** permitted by the high capacity of the trains and the efficiency of the railway vehicles **offset the extra cost of investment**, over the entire depreciation term.

  If, of course, the customer base is there!

- **The more the living standard of a country increases, the more the economic advantage of the BRT compared to the tramway decreases.**
The cities involved in a tram project

Cities with 300,000 to 1,000,000 inhabitants are the best suited for the implementation of a tram network on the principal traffic routes and the re-organisation of their initial bus network.

The choice of the traffic routes to be equipped with a tram line is based on the potential patronage:

- For trams 30 meters long: 40 to 80,000 passenger per day
  2,000 to 5,000 passenger per hour per direction

- For trams 45 meters long: 80 to 160,000 passenger per day
  3,000 to 10,000 passenger per hour per direction

- For hinged trams 70 meters long: 120,000 to 240,000 passenger per day
  6,000 to 14,000 passenger per hour per direction

The Istanbul tram line, which is likely the world’s most frequented, carries 260,000 passengers per day exclusively at ground level.

Tram length can be increased progressively. The higher the capacity is the cheaper the system is per passenger.
2 – THE TRAM (RE)BIRTH IN FRANCE

A SUCCESS STORY

Montpellier

Mulhouse
1. A local transport authority system (LTA)
   - Area
   - Competence
   - Organization

2. The financial environment
   - Low traffic fares (30% operating cost)
   - Special local tax for Public Transport (based on salaries) paid by all public and private companies: « versement transport »
   - Low national State subsidies

3. Contractual links between LTA and Operators
   - Operating PPP contracts « Délégation de service public »
   - Exclusive operating rights (usually)
   - Multimodal and intermodal contractual relations (bus, tram, P+R, all types of fares, bicycles, trains,...)
The first steps

After the 2nd World War, buses replaced old trams in all French towns, but buses are too small to be a right solution to urban growth.

In Germany the old tram networks were modernised with a big increase of Public Transport patronage and a good adaptation to urban expansion.

During the seventies, with the first oil crisis, the question of rebuilding tram lines should be asked. Nantes and Grenoble were the first towns daring to do. After many opposition and protests, the new tram lines opened in the eighties and were immediatly a big success.
The projects boom

In the nineties Stasbourg opened a revolutionary tram line: 100% low floor vehicle, downtown area transformed into pedestrian area, urban renewal all along the line, new urban landscape.

After these spectacular successes, many french towns wanted to follow these examples: Paris, Montpellier, Orleans, Lyon, Bordeaux, Nice, Le Mans, Marseille...

Today 28 french towns have tram lines in operation or in construction. Only 2 of the 30 most important french towns have not tram lines or tram project.
A metro in the street

With a near 100% priority traffic lights, they stop only in the tram stations.

Commercial speed: only 20% less than Parisian underground:
- 20km/h new French trams
- 24km/h Parisian urban metro
(for the same distance between stations)
A moving walkway

To go into the tram:
No steps like a bus,
No stairs like a metro

Platforms are at the same level than the vehicle and the street pavement
NEW TRAMS, A REVOLUTION FOR PUBLIC TRANSPORT

An integrated and multimodal network

**Bus and Tram and P+R and Bicycle**

With a *single and unique* ticket
A renewed town

Building a new tram line in an existing town mean to rebuild all the street around the tram track.

And the track can be covered with stones or grass or other different surfaces, giving many kind of sights to the street.

The new urban landscape created by tram line is appreciated not only by tram users but also by town’s residents.
NEW TRAMS, A REVOLUTION FOR PUBLIC TRANSPORT

Montpellier

Grenoble

Strasbourg
THREE CAUSES FOR THE TRAM SUCCESS

1- An adapted public transit mode :
   For 3 000 to 10 000 people/hour, modern trams are the most efficient transport mode. BRT is a less expensive investment, but the operation cost is 2 or 3 higher than tram, because of low vehicle capacity.

2- An urban renewal tool :
   Compared to a metro project, tram project renews urban landscape all along the route. So the investment cost has a positive impact even for non users.

3- Rails in the street reduces car traffic : »Good for residents, good for the cities»
   To reduce car traffic in French cities, new trams are more acceptable politically than buses :
   
   less noise, less pollution, more grass!
3. THE CASE OF MONTPELLIER

An example of a successful choice in favor of the tramway

A rapidly growing city in Europe

Sustainable mobility: a global approach (urban planning, paid parking pedestrian zone, ...)

The construction of a 55 km tramway network

Integrated and intermodal Public Transport network
A RAPIDLY GROWING CITY IN EUROPE

- 1945: 100,000 residents
- 2010: 420,000 residents
- 450 Km2
- 31 towns, including the city of Montpellier (255,000 residents)
- Capital of the Languedoc-Roussillon region (2,550,000 residents)
For mobility policy, Montpellier Agglomération has defined a global approach that covers all mobility-related programs:

- Coordinating urban planning and Public Transport infrastructure
- Developing public transport with a large tram network
- Integrating Public Transport (buses and trams) with mobility services (bicycles, P+R, car sharing, ...)
- Installing priority traffic lights for trams (99% without stops)
- Limiting car traffic in the city with a strong parking policy and a systematic use of paid parking in “the city of 1900”
- Coordinating moderate public transport fares with higher parking fees
- Transforming the entire historical center into a pedestrian area,
- Developing “active modes” of transport: - cycling,
  - walking.
All the new urban development areas in Montpellier are located along future and existing tramway lines.
PAID PARKING

First step in congestion charges and essential tool in mobility policy

Studies show that as long as people can park easily and free of charge at their destination, they will choose to drive their car rather than take alternative means of transport.

In Montpellier:

→ All parking on public streets is paid in the central zone.

→ Residents may park for free or at persuasive rates.

→ Fast rotation of free spaces is encouraged.

→ Home-work parking is discouraged.

Thanks to these measures, the usage rate of public transport is one of the highest in France, as is the proportion of public transport expenses with respect to receipts.
In 2004, Montpellier’s pedestrian zone was already quite large, considering that one could walk over 1,500 meters through the historical center and the new Antigone district without crossing a single street travelled by cars. Numerous streets in the old part of the city could still be accessed by car.

After much debate on the subject, it was decided to extend the pedestrian-only zone to cover the entire old city and its

22 km of narrow streets covering 50 hectares.

The zone is entirely controlled by removable barriers; only local residents may enter the zone once a day for a maximum of 30 minutes; deliveries are authorized until 10:00 am.
THE CREATION OF A 4 TRAM LINES NETWORK IN 15 YEARS

55 kms, 2 Billion USD, 70 million passengers / year on tram lines

**Line 1:** 16 km, opened in 2000, backbone of tram network in the major area of development.

- **33 vehicles 40m, 285 people**

**Line 2:** 17,5 km, opened in 2006, located on the historical axis of communication.

- **22 vehicles 30m, 210 people**

**Line 3:** 17,5 km, opening in 2012, is intended to reach sea and beaches.

- **19 vehicles 45m, 310 people**

**Line 4:** 8,5 km, opening also in 2012 will enable internal service of the large town center.

- **9 vehicles 30m, 210 people**
But for Tram, Buses, P+R and Bicycle self service:
One single ticket
A FUTURE WITHOUT OIL
"By 2050, the cities that managed to create a transport infrastructure network not running on oil will have a decisive advantage."
Georges Frêche, President of Montpellier Agglomération, on the launch day of work on Line 3 (April 2009)

A CONTROLLED INVESTMENT
Tramway line 1: an infrastructure four times less expensive than a metro and transporting as many travelers as a line of the Marseille metro, the large neighbor.

A MORE BEAUTIFUL CITY
The construction of the tramway, surface transport, beautifies and renovates the roadways used, letting even those who will not use it share in the benefit of the investment.

A GOOD QUALITY / PRICE RATIO
The operating cost savings offset the investment cost and put the total cost per passenger transported on the same level as that of a bus passenger.
PARK AND RIDE MANAGEMENT: How to raise PT use

Downtown car parks have two important kind of users: commuters, and leisure and shopping visitors.

Park and Ride management wants stopping these two kind of downtown users before entering in the city, but these users are very different.

Commuters are alone in their car and visitors are generally several.

TAM proposes two different fares in park and ride:

- Free parking and PT use paying with PT season ticket for commuters
- Paying parking and free PT use for all car passengers for visitors with a P+R ticket

P+R ticket fare is always less expensive than 2 hours parking fare in downtown car parks.
Close-up on intermodal solutions

**P+R**
Tram + Bus + private cars + private and public Bicycles + car sharing

Safe bicycles with a « Velomagg » closed shelter
« Only users » access
Vélomagg’ public bicycle service

1) 800 self-serve bicycles from 50 automated bike stations at convenient partner locations (community centers, public facilities, business areas, tram and bus stations):
   - Occasional use.... : several different fares
   - Public transport annual season ticket (40,000 in Montpellier) : .... Free!

2) Guarded parking for private bicycles at all P+R and downtown TAM car parks in city center.

3) 1,000 bikes for long-term rental:
   - Students
   - Companies (Corporate Mobility Plan).
Velomagg’ station and securised bicycle shelter in P+R « Occitanie »
10 YEARS TO RAISE PT USE * 2.4

Base 100 in 1998

- Total operation cost
- Total Client Incomes
- Passengers
- Kilometers
- Places-Kms

Events:
- mai 1999: REB montée par l'avant
- juin 2000: Tram Ligne 1
- dec 2002 - 2003: Allongement rames ligne 1
- dec 2006: Tram Ligne 2

10 YEARS TO RAISE PT USE * 2.4
4. The Tramway/BRT compared economic analysis

4.1 Method of comparison

4.2 Close-up look at the compared analysis of tramway, bus, and BRT costs in the case of Montpellier

4.3 The main lessons from the comparison
4.1 Method of comparison

- The comparison of bus, BRT, tramway, or metro solutions is generally incomplete.

- In the feasibility studies of the projects, the comparison pertains to the investment costs of the different solutions as a priority.

And the operating cost is taken into account without direct relationship with the investment.

- In Montpellier, the transport operator Transdev, present for 30 years in the semi-public company TaM, is responsible for:
  - Steering the bus, tramway, infrastructure, and rolling stock investments
  - Organizing the construction of the tramway lines
  - And operating the entire bus/tramway network (including the exchange centers).

- The operator has all of the figures necessary for the comparison. The examination of the same data in the other networks of the Transdev Group shows that the results are valid in most of the European situations.
4.1 Method of comparison

- **Using the place/kilometer offered as a base unit for comparisons**
  - The kilometer traveled by a vehicle does not permit comparison because of differences in capacity
  - Capacity = seated places + standing places at 4 people per available m².

- **Comparing the total annual investment and operating costs**
  - Annual investment cost = total cost over the average duration of depreciation (23 years for a tramway line) + annual financial expenses
  - Operating cost = 2008 TaM cost accounting

- **Simulating a BRT (BHNS in France) in place of line 1 of the tramway**
  - Fully on reserved site like the tramway with the same commercial speed
  - Construction and equipment identical to the Nantes BRT (line 4), named Busway (registered trademark)
  - Investment cost per kilometer equal to the Nantes BRT (Transdev Group)

- **Keeping Montpellier's "ordinary" bus network as a reference.**

- **Simulating line 3 of Montpellier's tramway**
  Currently at the end of construction, all of the costs are known, and its operating cost comes from TaM's 2008 data.
## MONTPELLIER

### YEAR 2008

<table>
<thead>
<tr>
<th>PHYSICAL DATA</th>
<th>TRAMWAY (actual figures)</th>
<th>TRAMWAY (actual figures)</th>
<th>URBAN BUSES (actual figures)</th>
<th>simulation BRT (like Nantes)</th>
<th>TRAMWAY (3-year forecast after implementation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling Stock</td>
<td>33 trains (285 places)</td>
<td>24 trains (210 places)</td>
<td>136 buses</td>
<td>33 articulated NGV buses (105 places)</td>
<td>23 trains (285 places)</td>
</tr>
<tr>
<td>Veh/km (in 1000)</td>
<td>1,801</td>
<td>1,470</td>
<td>5,319</td>
<td>1,800</td>
<td>1,777</td>
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<tr>
<td>Places offered (in 1000 PKO)</td>
<td>501,100</td>
<td>308,700</td>
<td>425,800</td>
<td>189,000</td>
<td>506,400</td>
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<tr>
<td>Transported travelers (in thousands)</td>
<td>30,000</td>
<td>13,600</td>
<td>18,620</td>
<td>11,300</td>
<td>22,000</td>
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</table>

### INVESTMENT COST (in millions of 2004 euros)

<table>
<thead>
<tr>
<th>2008 ANNUAL COST</th>
<th>COST per PKO (places/km offered)</th>
<th>2008 total</th>
<th>investment</th>
<th>operating</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>depreciation and financial expenses</td>
<td>€27.9 M</td>
<td>€31.2 M</td>
<td>€9.2 M</td>
<td>€9.5 M</td>
<td>€30.8 M</td>
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<tr>
<td>operating</td>
<td>€15.9 M</td>
<td>€11.1 M</td>
<td>€30.4 M</td>
<td>€14.3 M</td>
<td>€13.4 M</td>
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<tr>
<td><strong>2008 total</strong></td>
<td><strong>€43.8 M</strong></td>
<td><strong>€42.3 M</strong></td>
<td><strong>€39.6 M</strong></td>
<td><strong>€23.8 M</strong></td>
<td><strong>€44.2 M</strong></td>
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<tr>
<td>investment</td>
<td>5.6 cents</td>
<td>10.1 cents</td>
<td>2.2 cents</td>
<td>5.0 cents</td>
<td>6.1 cents</td>
</tr>
<tr>
<td>operating</td>
<td>3.2 cents</td>
<td>3.6 cents</td>
<td>7.1 cents</td>
<td>7.6 cents</td>
<td>2.6 cents</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>8.8 cents</strong></td>
<td><strong>13.7 cents</strong></td>
<td><strong>9.3 cents</strong></td>
<td><strong>12.6 cents</strong></td>
<td><strong>8.7 cents</strong></td>
</tr>
</tbody>
</table>

### COST per TRAVELER transported

<table>
<thead>
<tr>
<th></th>
<th>investment</th>
<th>operating</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>investment</td>
<td>€0.93</td>
<td>€2.29</td>
<td>€0.49</td>
</tr>
<tr>
<td>operating</td>
<td>€0.53</td>
<td>€0.82</td>
<td>€1.63</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>€1.46</strong></td>
<td><strong>€3.11</strong></td>
<td><strong>€2.12</strong></td>
</tr>
</tbody>
</table>
The BRT costs three times less in investment, but it is as expensive to operate as the tramway. Brought back to the price per place offered, it is more expensive than the tramway on lines 1 and 3 with 40-meter trains.

The choice between a BRT with a higher capacity and a modern high-capacity tramway is mainly related to the potential customer base.

Given the significance of the initial investment of a tramway line, it is better to have large trains (40 m), with a low extra investment cost (2 to 3% of the total) and a low extra operating cost (around 5%).

Settling for a traditional bus network does not cost less per place offered. In order to develop the use of public transport, it is better to invest in mass transport.
ANNEXE 1 Urban growth and development of public transport

- Faced with the challenges of growth, Montpellier established an ambitious urban project and constructed a transport network virtually not existing in the 1960s.

- The network was organized around "bus priority areas" (name given to a local form of BRT).

- But "the priority areas" have quickly become saturated.

- And in 1995, Montpellier's elected officials, under the leadership of Georges Frêche, decided on the construction of a network of tramway lines taking up the layouts of the "priority areas".
The bus priority areas heralded the tramway

Bus viaduct constructed downtown on top of the high-speed train tracks.
Viaduct of the bus priority area

Transformed into tramway line
LA LIGNE 1 : 10 ans après sa mise en service, une réussite complète

LA LIGNE 1 EN 2012

- Longueur : 15,8 kms et 29 stations.
- Maillage : 3 pts de correspondance avec L2, 5 avec L3 et 7 avec L4
- Horaires : de 5 heures à 1 heure du matin (2h le week-end).
- Fréquence de passage : de 3 à 5 minutes
- Vitesse commerciale moyenne : 20 kms/heure.
- 33 tramways Alstom Citadis 401 et 402
  - 40 mètres de long,
  - 2,65 mètres de large,
  - 285 personnes (4 personnes/m2).
- 130 000 voyageurs par jour fin 2012
- 30 millions de voyageurs par an.
- 5 parkings tramway : 2 600 places dont 1 ouvrage de 1200 places à Odysseum
- Coût d’investissement : 427 M€.
LA LIGNE 2 : le tramway sort de la ville

LA LIGNE 2 EN 2012

- **Longueur :** 17,5 kms et 28 stations avec 2 voies uniques de 4 kms aux 2 extrémités.
- **8 parkings tramway :** 1.285 places,
- **Maillage :** 2 points de correspondance avec L1, 1 avec L3, 4 avec L4
- **Horaires :** 5h à 1h du matin (de 5 à 2h30 les vendredis et samedis).
- **Fréquence :** 5 à 7mn sur la partie en voie double, 10 à 15mn sur les voies uniques.
- **Vitesse commerciale :** 21 km/h.
- **18 Citadis 302** de 30 mètres de long et 2,65 m de large et **4 Citadis 402** de 40 mètres
- **50 000** voyageurs par jour en 2012
- **14 millions** de voyageurs en 2012.
- **Coût d’investissement :** 400 M€ (€ 2004) contre 424 M€ prévus au projet initial).
Les lignes 3 et 4 : direction la mer et les nouveaux quartiers

- **Longueur** :
  - L3 : 17,5 kms et 29 stations.
  - L4 : 8,5 kms et 17 stations

- **Mêmes horaires et fréquence** que la ligne 2.

- Des **voies uniques** en fourche sur la partie Sud desservies à demi-fréquence.

- 19 **rames** de 40 mètres pour la L3 et 9 rames de 30m pour la L4.

- **Fréquentation** prévue fin 2012
  - L3 : 50 000 voyageurs par jour,
  - L4 : 20 000 voyageurs par jour
  - 21 millions de voyageurs par an.

- Décoration des rames : **Christian LACROIX**.

- **Début des travaux** : 19 mars 2009.

- **Mise en service** : avril 2012.

- **Coût d’investissement** : 530 M€ (en euros 2008).
Evolution de la capacité du réseau TaM

en millions de Places par Kilomètres Offertes
<table>
<thead>
<tr>
<th></th>
<th>RIDERSHIP Per Year</th>
<th>PASSENGERS Per kms-vehicles</th>
<th>OPERATING COST Per Kms</th>
<th>OPERATING COST Per Passengers</th>
<th>PUBLIC SUBSIDY Per Passengers</th>
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<tbody>
<tr>
<td>TRAMWAY</td>
<td>45 millions</td>
<td>13.4</td>
<td>9.00€</td>
<td>0.70€</td>
<td>0.27€</td>
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<tr>
<td>URBAN BUSES</td>
<td>18 millions</td>
<td>3.5</td>
<td>6.20€</td>
<td>1.80€</td>
<td>1.46€</td>
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<tr>
<td>SUBURBAN BUSES</td>
<td>3 millions</td>
<td>1.3</td>
<td>3.20€</td>
<td>2.50€</td>
<td>2.23€</td>
</tr>
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</table>
AN EXAMPLE OF A SUCCESSFUL APPROACH OF A FRIENDLY POLICY FOR PEDESTRIANS AND CYCLES

CHOISISSEZ LA VILLE QUE VOUS VOULEZ

ZONE 30
DUI NON
• Limiting car traffic with a **strong parking policy** and a **reduction of available space** for private car traffic

• **Doubling Public Transport** use since 1990

• Building a **6 lines tram network** in 20 years with a large interconnected urban bus network

• And an **integrated and intermodal public transport network** like Montpellier

• New specific approach in France to develop « active modes » cycling and walking:
A SPECTACULAR DEVELOPMENT OF CYCLING

• 500 kms of bicycle paths in 20 years
• 130 000 bicycle frequent users

• Innovations:
  - Double way authorised to bicycles in one way street (400 kms)
  - 2 huge bicycle parkings near central railway station for commuters (850 spaces and 430 spaces)

• Results in 2010 in cycle modal shift:
  4% in 1990 / 8% in 2010

• 2020 target: 20% like in Freiburg Germany
<table>
<thead>
<tr>
<th>Mode</th>
<th>1997</th>
<th>2009</th>
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<tbody>
<tr>
<td>Private car</td>
<td>53%</td>
<td>46%</td>
</tr>
<tr>
<td>Public Transport</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>31%</td>
<td>33%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
5. Examples of European Tramway - MONTPELLIER
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4. Examples of European Tramway - STRASBOURG
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4. Examples of European Tramway - GRENOBLE
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4. Examples of European Tramway - NANTES
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4. Examples of European Tramway - NANTES
4. Examples of European Tramway - MULHOUSE
4. Examples of European Tramway - MULHOUSE
4. Examples of European Tramway - ORLEANS
4. Examples of European Tramway - TENERIFE