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CTCN Training Sessions on Climate Technologies

February 2015

URBAN TRANSPORTATION TECHNOLOGIES TO ADDRESS CLIMATE CHANGE

AN OVERVIEW

Dr. Alberto Müller

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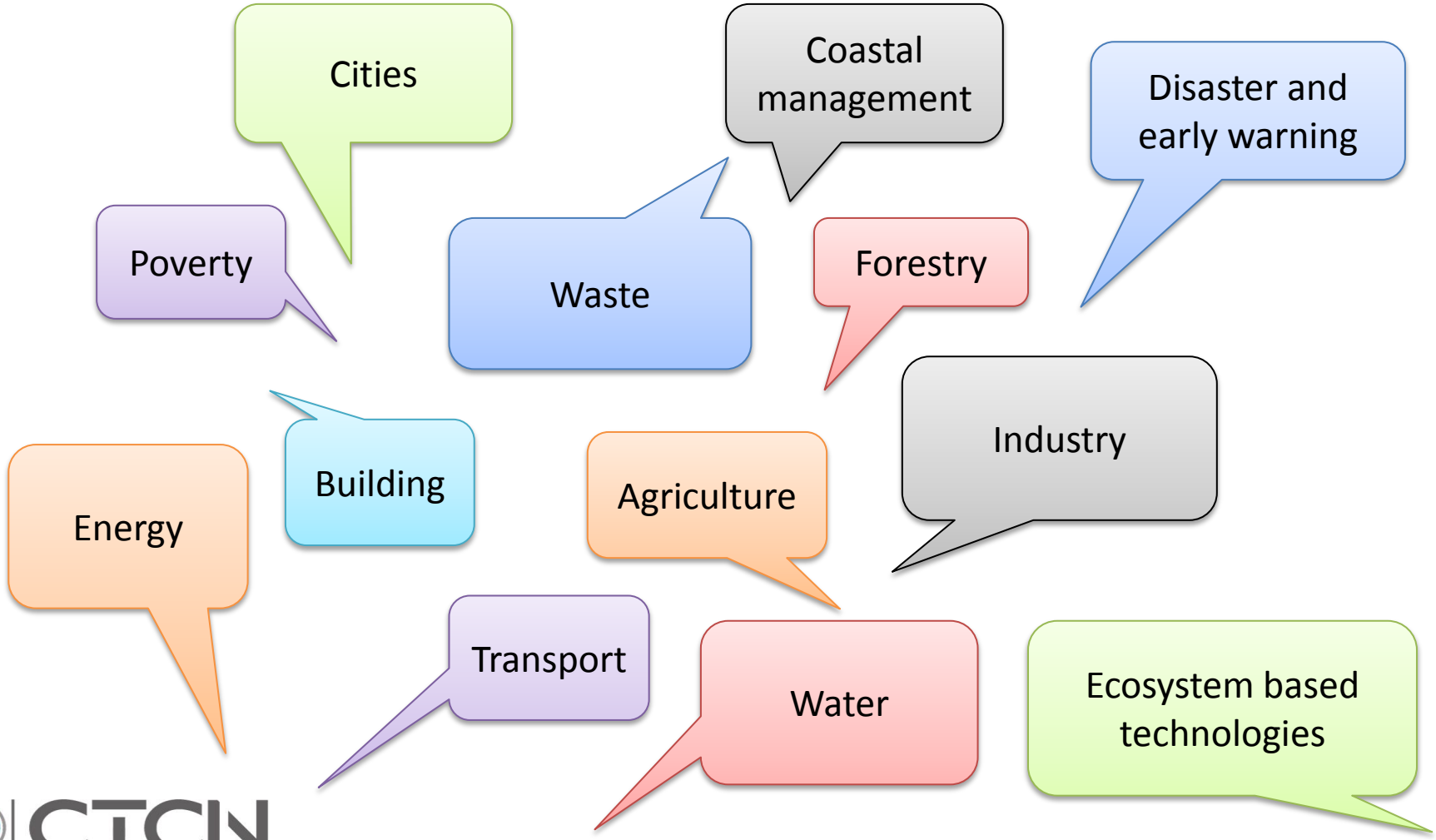
An introduction to climate technologies…



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Dr. Alberto Muller

The webinar will be presented by Dr. Alberto Müller.

Alberto Müller has a PhD in Economics (Sao Paulo University – Brazil). He has worked for more than twenty years in the transportation sector, as an official at the Argentina's Government and as a consultant.

He is nowadays a full time professor and researcher at the University of Buenos Aires, where he teaches Industrial Organization and Project Evaluation. Regarding transportation, his main fields are Urban, Road and Rail Transportation.

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URBAN TRANSPORTATION

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General purpose

- Provide an overview referred to urban transportation across the world, highlighting the main issues at stake
- Introduce the climate change challenges related to urban transportation
- Introduce the various technologies available to develop more efficient/climate-smart/clean transportation systems)
- Explain the barriers faced by developing countries to use more of these technologies
- Develop some policy guidelines

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URBAN TRANSPORTATION

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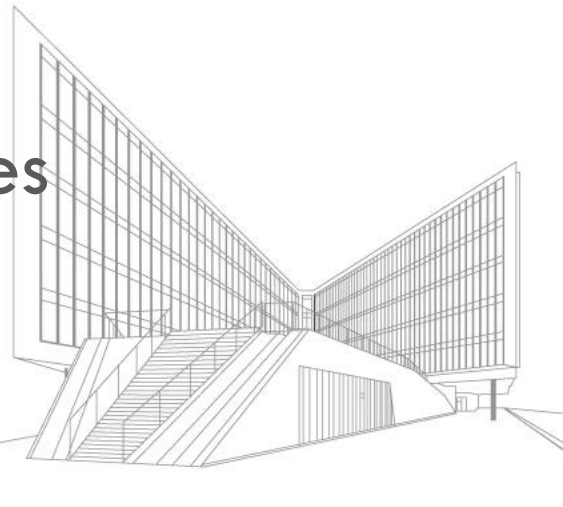
SUMMARY

1. Transport and Climate Change
2. Cities and urban transportation
3. A quick world overview

   Appendix: A simplified approach
4. Policy: general principles
5. Policy: the tools
6. Policy: Sketching out some guidelines

Conclusions - References



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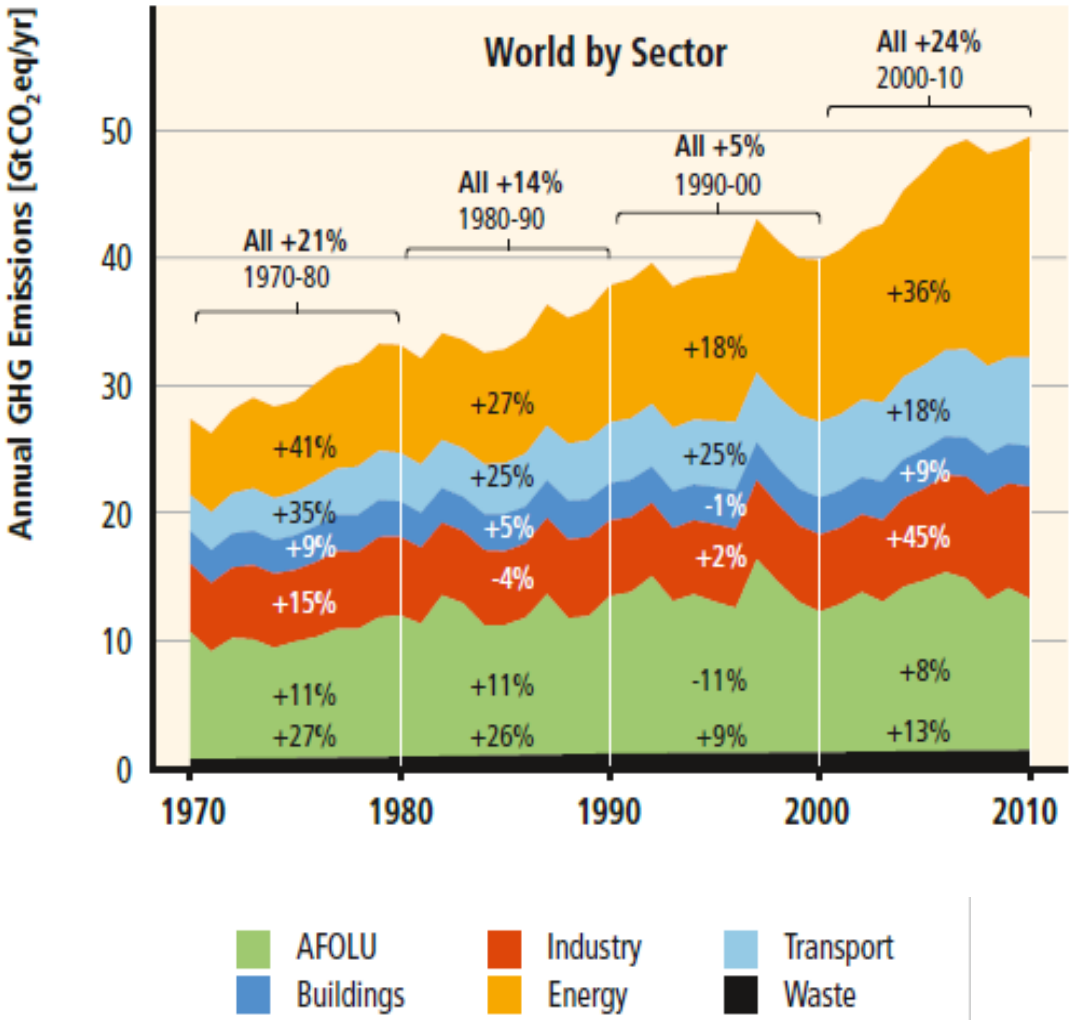
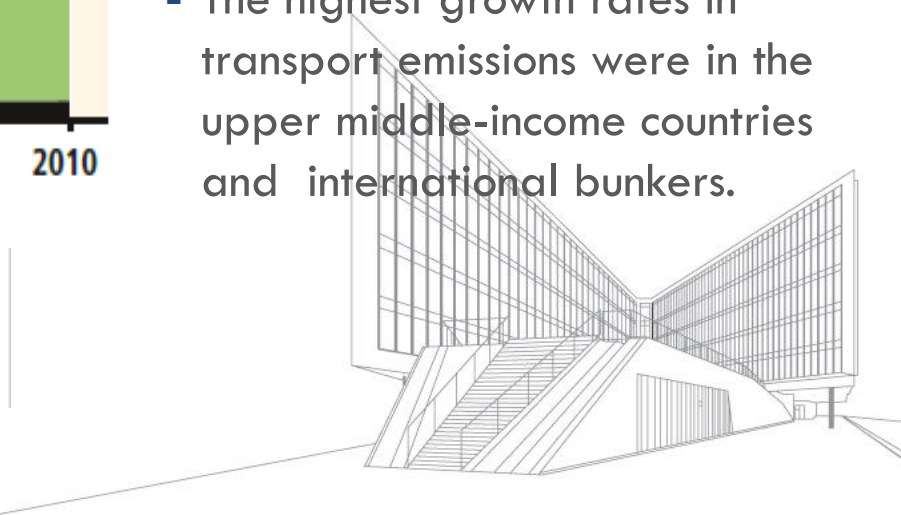
1. Transport and climate change



- Transport sector is responsible for 23% of total energy-related CO2 emissions
- Global transport GHG emissions grew from 2.8 GtCO2eq in 1970 to 7 GtCO2eq in 2010
- The OECD countries contributed the largest share of the emissions (60 % in 1970, 56 % in 1990, and 46 % in 2010)
- The highest growth rates in transport emissions were in the upper middle-income countries and international bunkers.



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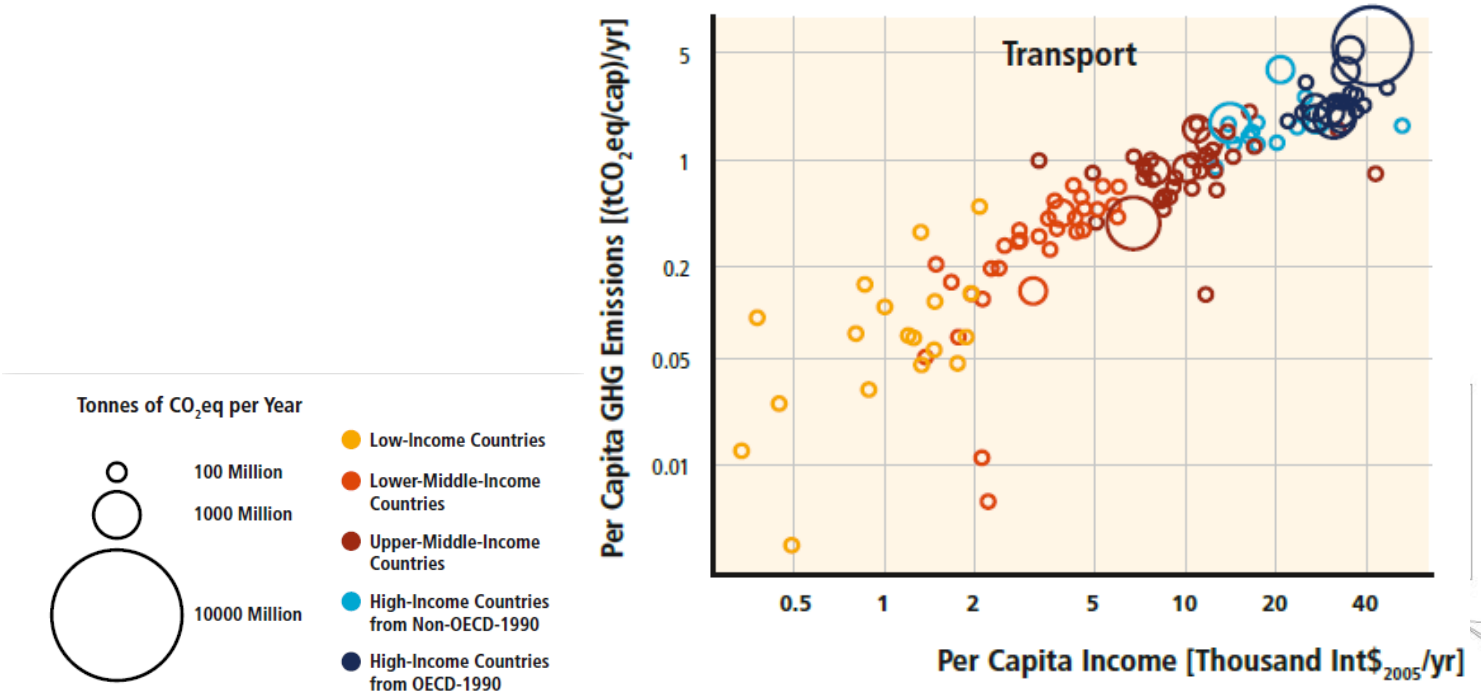
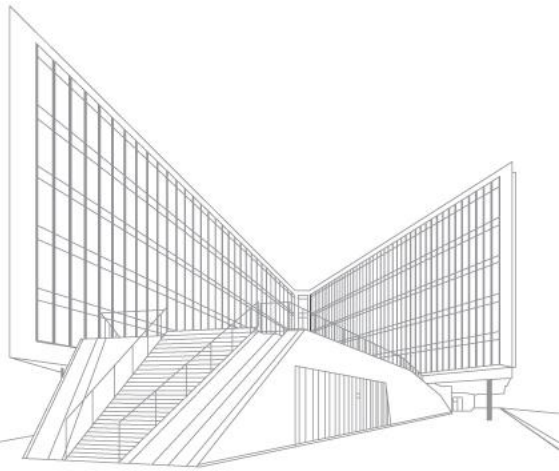
1. Transport and climate change

Strong correlation between per capita transport emissions and per capita incomes. Alignment is sharper in the high-income countries as the demand for *personal transportation* increases as standards of living rise and economic activity increases (IPCC, 2014).



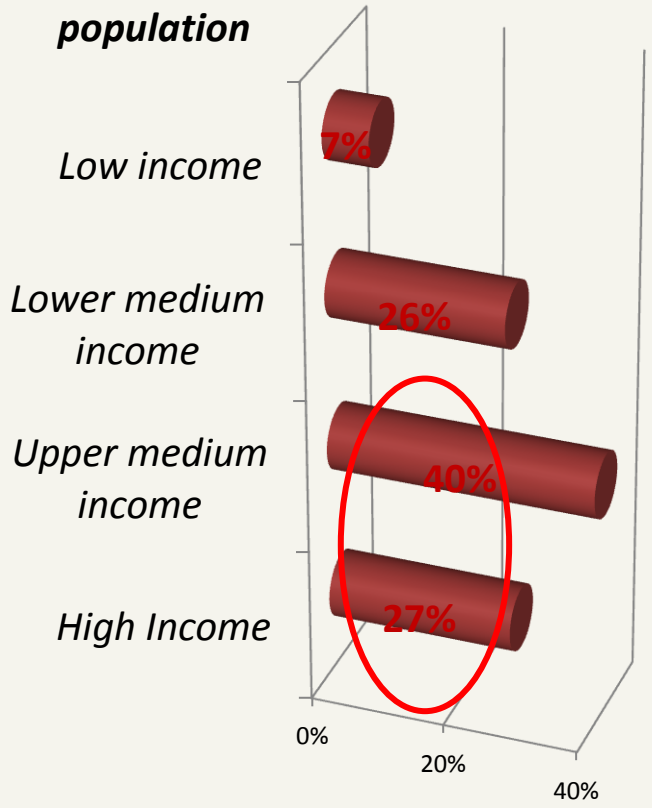
1. Transport and climate change

- Drivers of transport sector CO2 emission growth over the past decades (IPCC, 2014).:
  - Increasing demand for passenger and freight transport
  - Urban development and sprawl
  - Lack of rail and bus transit and cycle infrastructure in many regions
  - Transport behavior constrained by lack of modal choice in some regions
  - High fuel-consuming stock of vehicles
  - Relatively low oil prices
  - Limited availability of low-carbon fuels



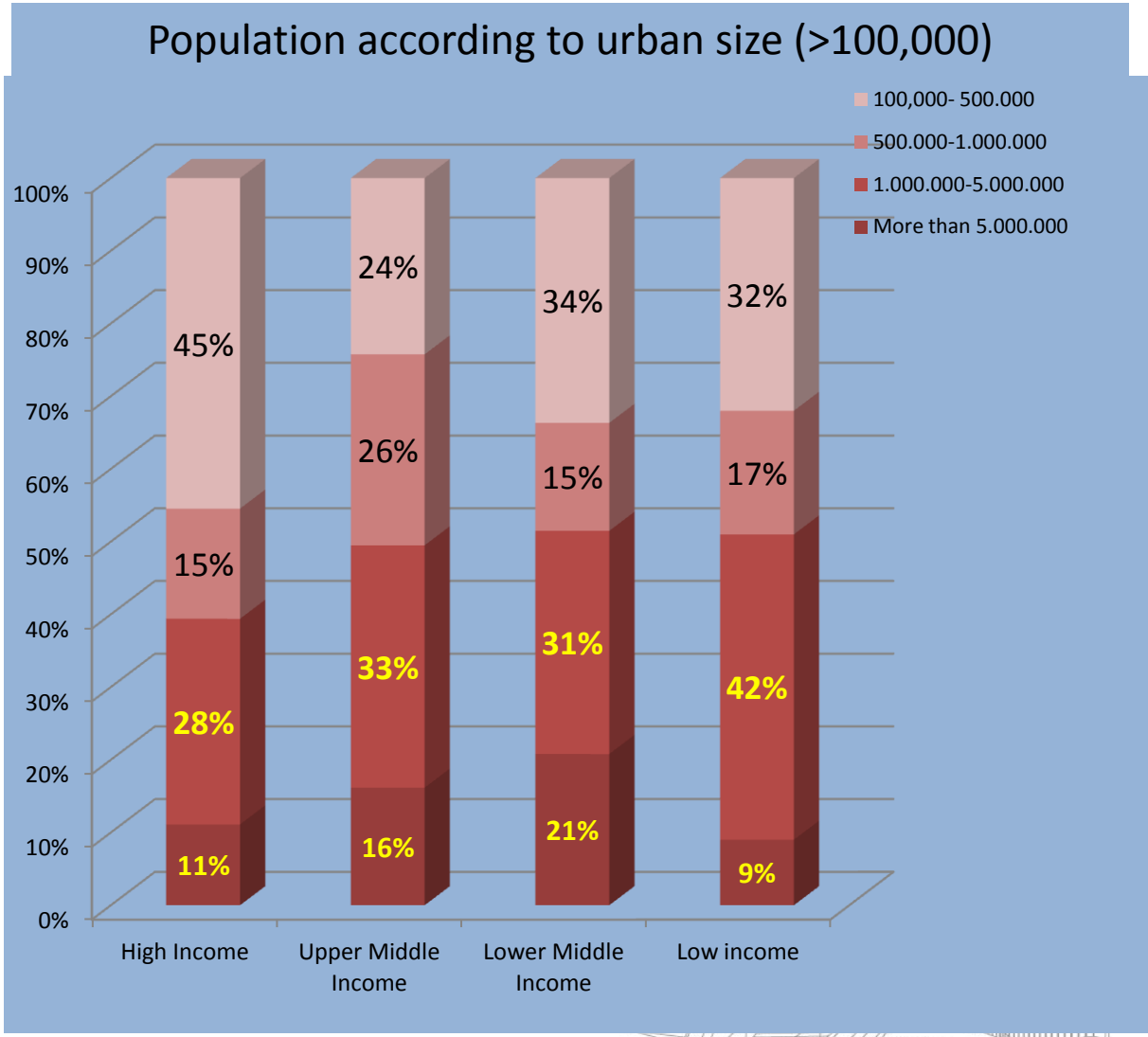
2. Cities and urban transportation

- Urban growth is a generalized phenomenon, both in developed and developing countries
- At the beginning of the XXI Century, urban population has surpassed rural population
- Urbanization rate in developed countries: 90%
- Most urban population belongs to high income and upper middle income countries



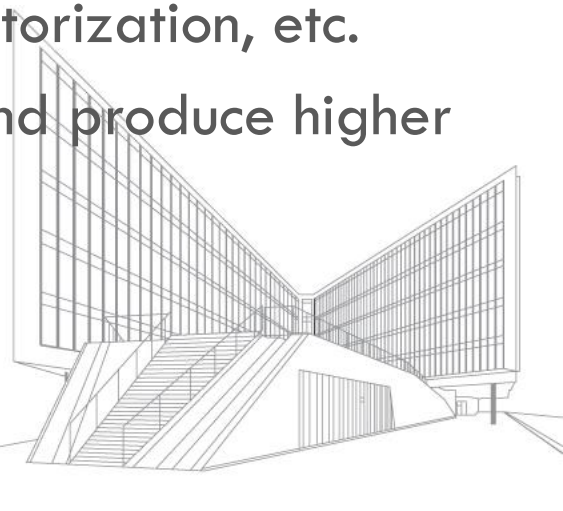
2. Cities and urban transportation

- More than 50% of urban population lives in cities of less than 0,5 million inh.
- Large metropolitan areas (more than 5 million inh.) comprise 12%
- More balanced distribution of urban population (for cities > 100,000 inh.) in high income countries.



2. Cities and urban transportation

- Cities develops their own “basic road system”.
  - ✓ Up to 200,000-500,000 inhabitants=> the basic road system is enough to convey travel demand.
  - ✓ Larger sizes mean normally more density, as well as greater distances=> more capacity and higher speeds=>specific interventions (from parking restrictions up to metro systems)
- Requirements depend heavily on the specific features of each urban area: density, location of population and jobs, motorization, etc.
- Larger cities lead to more energy requirements and produce higher external impacts



2. Cities and urban transportation

- More than 50% of energy consumption is devoted to transportation (63% in OECD countries)
- About half of the energy spent in transportation is used for urban transportation.
- Urban transportation is of great concern, due to congestion, local pollution and greenhouse gases emissions: 2/3 of fuel consumption can roughly be attributed to the larger cities (more than 1 million inhabitants)
- In developed countries, 40% or more of trips is carried by automobiles

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2. Cities and urban transportation

- There is potential for a reduction of energy consumption, greater than in the case of intercity transportation.
- Consensus is widespread: moderate the use of automobile.
- But this means dealing with a complex and rather unpredictable universe of phenomena – vicious circles may arise

And moreover, cities are all different…

3. A quick world overview

- **Three (rough) urban patterns in developed countries**

1. Far-Eastern countries (Tokyo, Osaka, Hong Kong, Singapore)
   - Huge and high density cities
   - High patronage of public transportation (up to 60%) - Restrictions to automobile circulation

Graph

2. Western-Center European Countries (Berlin, Paris, London, Vienna, Milan)
   - Compact urbanization – strong control on land use
   - Well developed public transportation – moderate share of total demand (30-40%) – less than automobile's
   - Metros in all large cities - Streetcars (Germany, Austria, ex communist countries) - High share of bicycles (Germany, Netherlands)

3. North American/Australia (Los Angeles, Houston, Sydney, Melbourne, Ottawa
   - Very low density urbanization – urban sprawl
   - Urban regions lacking a strong central business district (Los Angeles)
   - High share of automobile (70% or trips)
   - Low patronage of public transportation (10%)

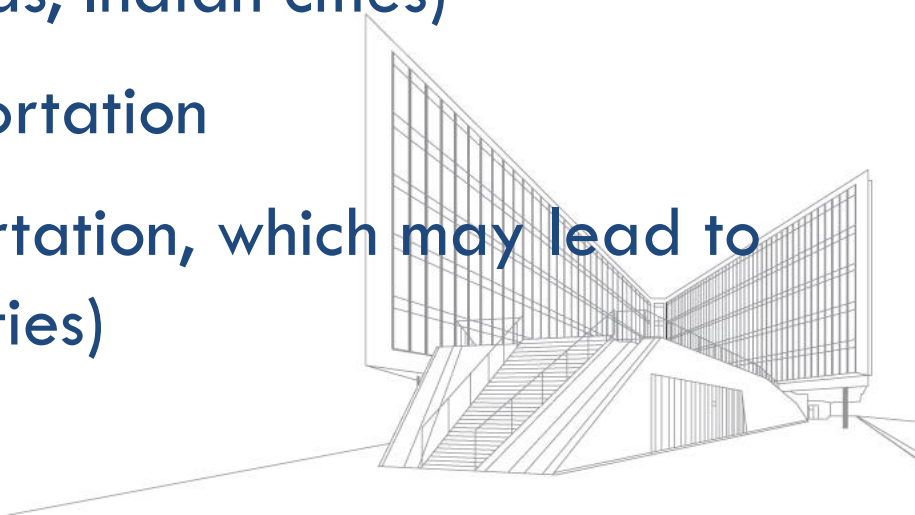
3. A quick world overview

Developing countries:

- No general patterns

Graph

- Cities tend to be compact, although heterogeneous
- High public transportation patronage (40-70%) and motorization is lower than developed countries
- Neverthesless, “premature congestion” is very present (São Paulo, Bangkok, Caracas, Indian cities)
- Social exclusion from transportation
- Informality in public transportation, which may lead to congestion (La Paz, Indian cities)



3. A quick world overview

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A Simpilfied Approach

A simple analytical approach about the relationship between urban pattern and transportation can be found in the Appendix

For more details, please contact mrecalde@fundacionbariloche.org.ar

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4. Policy: general principles

- In growing urban areas, assure a compact urbanization, preventing low density sprawl as well as leap-frog phenomena.
- Mitigate the environmental damage through the reduction of the emissions and other pollutants.
- Divert trips towards from automobile to alternatives that mean less cost, less fuel consumption and less environmental impact.
- Reduce the demand of trips
- Reduce the extent of trips
- Assure accessibility to transportation for everybody

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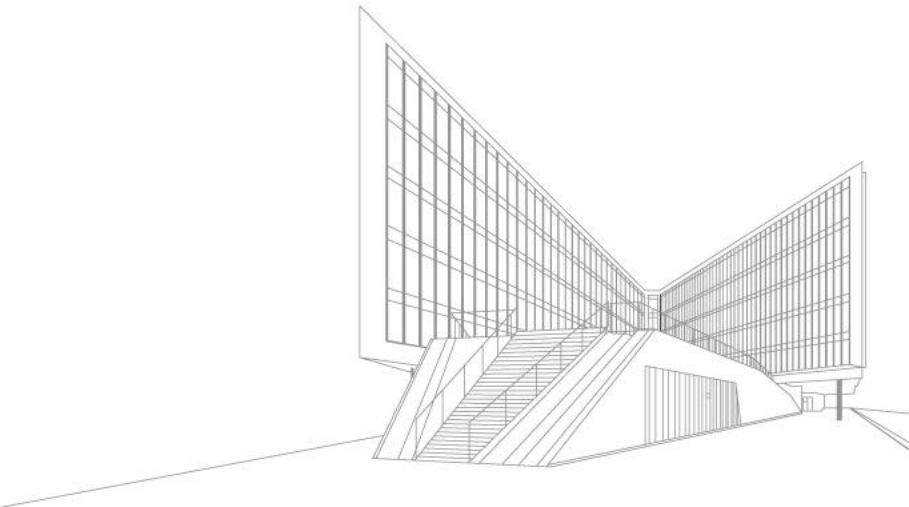
5. Policy: the tools

- Available tools:
  - Provision of public services and facilities
  - Enforcement and Regulations
  - Soft policies - Economic incentives



5. Policy: the tools

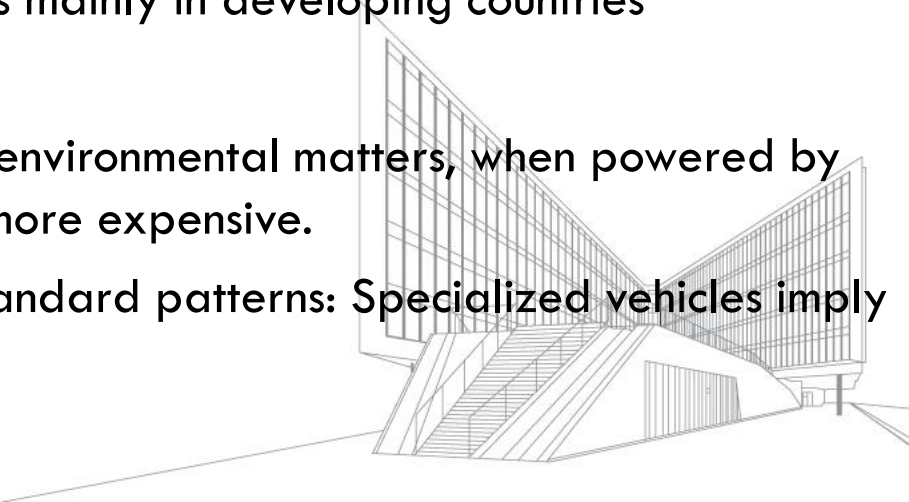
Provision of public services and facilities

- Conventional bus
  - The most widely option of mass transportation, due to low costo and flexibility
  - Diesel fuel or electric traction
  - Capacity: Up to 5,000-8,000 passengers/hour/lane
  - Low speed (less than 20 km/h in most cases) and subject to congestion effects => low competitiveness vis-à-vis auto
  - Informality and fragmentation in developing countries may hinder planning and rational management., and even contribute to congestion.

5. Policy: the tools

Provision of public services and facilities

- Bus Rapid Transit (BRT)
  - Bus on reserved lanes – Access stations – specialized vehicles
  - Diesel fuel or electric traction
  - Flexibiliy: May allow dual operation (as BRT and conventional bus)
  - Preserved from street congestion-Up to 35,000 pass/hour/lane
  - Speed: around 25-35 km/h
  - Better than more expensive solutions, as streetcars and metros
  - Widely adopted in Latin America (Curitiba, Rio de Janeiro, Bogotá, Quito, Santiago de Chile) but also in other cities mainly in developing countries
  - Investment: around us$ 10-15 million/km
  - Not very convenient both in energy and environmental matters, when powered by diesel engines; but electric vehicles are more expensive.
  - Trade off between specialization and standard patterns: Specialized vehicles imply more demanding maintenance



5. Policy: the tools

Provision of public services and facilities

- Bus Rapid Transit (BRT)

5. Policy: the tools

Provision of public services and facilities

- Streetcar – Light Rail Transit (LRT)
  - Rail technology – Electric traction
  - LRT: segregated – mixed operation is possible
  - High technology devices in modern versions (but Milan still runs 1928 cars)
  - Streetcars preserved in Central Europe-Melbourne, but abandoned almost everywhere – Modest revival in the last two decades
  - Investment: around us$ 30-35 million/km
  - Same speed as bus or BRT
  - An option for wealthy countries

5. Policy: the tools

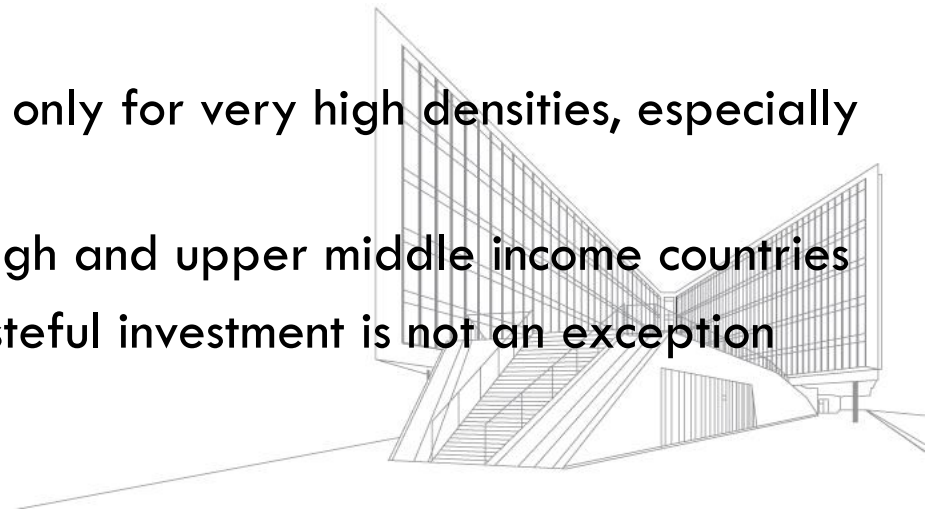
Provision of public services and facilities

- <u>Commuter railroads</u>
  - Rail technology – Electric o Diesel traction
  - Normally operated on lines built for several purposes (freight, intercity) - Option mostly limited to these cases
  - Most lines from the railway's "golden age"-Present in "long time ago" large cities.
  - Large capacity: up to 30,000-40,000 pass/hour.
  - Average speed: mostly 30-35 km/h
  - May allow operation of mixed trains (local and direct).

5. Policy: the tools

Provision of public services and facilities

- Metro Rail Systems
  - Rail technology – Electric traction
  - Operated normally on on-purpose trucks
  - Tunnel/Viaduct – No level crossings
  - "Heavy" and "light" versions
  - Large capacity: up to 70,000-80,000 pass/hour.
  - Average speed: mostly 25-35 km/h
  - Cost: from $us 50 to 200 millions/km, depending on headways and infrastructure (viaduct or tunnel.)
  - Well performant and expensive: only for very high densities, especially in developing countries
  - Present metro systems (160) in high and upper middle income countries
  - Not an all-reaching solution: wasteful investment is not an exception



5. Policy: the tools

Provision of public services and facilities

- Metro Rail Systems

5. Policy: the tools

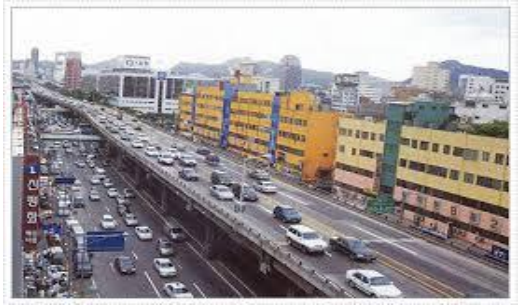
Provision of public services and facilities

- Metro Cable Systems
  - Cable car technology
  - A new option, developed in Latin America (Medellín, Bogotá, Rio de Janeiro, La Paz, Caracas), but also Portland
  - Capital cost: $us 5-10 million/km (La Paz)
  - Low capacity (10-15.000 passengers/day)
  - Expensive solution, viable especially in hilly areas
  - Also used as a means of social integration (Colombia, Brazil)
  - Environmentally friendly, but high energy consumer

5. Policy: the tools

Provision of public services and facilities

- Increasing capacity of the road system
  - From enlarging arterial avenues up to freeways
  - Capacity: up to 2,000 autos/lane/hour. – 35,000 autos/lane/day
  - Average speed: 60-90 km/h
  - Cost: $us 20-40 millions/km, in “normal” conditions (land value not included).
  - Possible short run effect: changing the place of congestion
  - Diversion of traffic from the basic road system – longer trips incentive
  - Segregated ways do not allow accessibility
  - Negative external impact (noise-visual intrusion) in dense areas



5. Policy: the tools

Provision of public services and facilities

- <u>Facilities for cycling</u>
  - Mainly but not only for small cities - Both for near home and center areas trips (public bicing)
  - Cost-effective solution
  - A healthy option for developed countries (Central Europe-Japan) – An eoconomic option for developing countries (Far East)
  - Diversion may be both from automobile and bus
  - Dilemma: more bikes may mean more congestion

5. Policy: the tools

Enforcement and regulations

- Fuel consumption standards
  - Long tradition in the US, starting from the first oil shock (although it has been skipped through SUV)
  - The EU has tried agreements without enforcement, not very unsuccessfully.
  - Debate around the "rebound effect": more economic vehicles may lead to more use of them, and therefore consumption may not diminish.
  - An option for developing countries, although enforcement may be weak.
  - Standards anyway are "imported" through the vehicles themselves, although with some delay

5. Policy: the tools
Enforcement and regulations

- Enforcement of emissions standards
  - Economists are prone to establish market for emissions; but this option - largely discussed – seems difficult to implement
  - Quantitative restrictions therefore are the only available way.
  - It may be effective if vehicles turnover is fast enough.
  - In developing countries, stringent standards may cause social distress.
  - Regarding global pollutants (green-house effects), it may be efficient to reduce emissions differentially in developed countries.
  - Local pollution will have to be faced by each city on its own.

5. Policy: the tools

Enforcement and regulations

- Restriction to vehicle circulation
  - Pedestrianization has proved to be effective as a means or reducing circulation and enhancing central urban areas, although it can lead to congestion around the boundaries.
  - Limitation of circulation according to the plate number (pair-odd, etc.) has shown ineffective to reduce circulation and emissions.
  - Limiting speed has been effective to abate fuel consumption, in the US case, and also to reduce accidents

5. Policy: the tools

Soft policies and economic incentives

- Congestion fees
  - Congestion fees point to reduce traffic.
  - Differentiated tolls on expressways may shift traffic to the non-tolled roads
  - A congestion fee that covers a congested entire area is more advisable
  - “double dividend” policy: allow traffic reductions, while resources can be devoted to public transportation.
  - Lower congestion improves the performance of bus transportation.
  - Congestion fees meet political resistance, due to its distribution issues and commercial interests.
  - Full implementation in few cases: Singapore, Stockholm, Oslo-Bergen-Trondheim, London, Milan
  - Response seems to be strongly related to the performance of public transportation
  - Not an easy option for developing countries

5. Policy: the tools

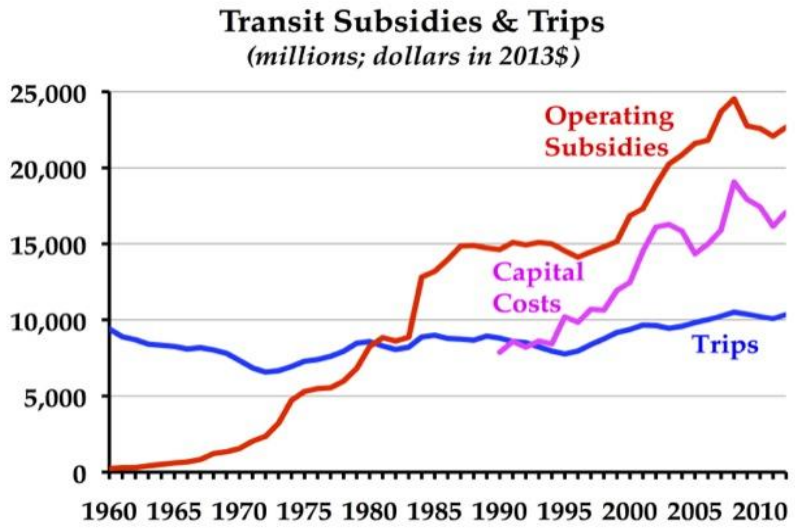
Soft policies and economic incentives

- Parking fees
  - The closest proxy of congestion fees – a valuable option
  - Applied in almost every city – double dividend policy
  - Mostly applied on public roads.
  - Shortcomings:
    - ✓ Driving in search of a parking place may add congestion
    - ✓ It encourages short trips, more turnover and more congestion.

5. Policy: the tools

Soft policies and economic incentives

- Public transport subsidies
  - An indirect way of a toll on automobile externalities
  - More frequency and more dense services mean benefits that are no captured by the tariff; hence the subsidy.
  - It is also a mean for income redistribution and social integration.
  - Subsidies are widespread, especially in developed countries: 50% of operating costs is a frequent case.
  - The diversion from auto is not assured, as the quality of service is very important, as well as social integration.
  - Subsidies increase with income: productivity stagnates while wage costs increase when income does.



5. Policy: the tools

Soft policies and economic incentives

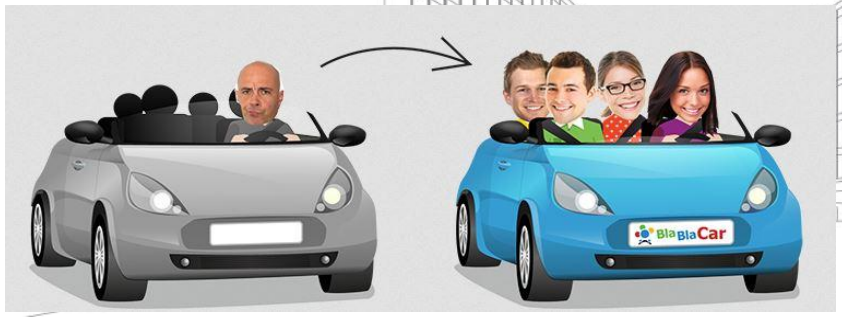
- <u>Public transport tariffs:</u>
  - "Basics": flat tariff – bias against combined trips, which could be attractive (and economically convenient)
  - Response: integrate ticketing.
    - ✓ Allow a second use within a short period
    - ✓ Zonal tickets, with or without illimited trips

  - Tickets for long periods (week, month, year) at a decreasing rate, in order to encourage buying in advance
  - Electronics has improved ticketing systems
  - In developing countries the flat tariff is mostly in place, for distributive reasons (low income people make longer trips).

5. Policy: the tools

Soft policies and economic incentives

- Carpooling
  - Encourage sharing the automobile, giving some preference (special lanes, cheaper parking).
  - Reduces the number of cars, without giving up the car.
  - It is inexpensive, and must be kept; but the impacts have been modest



5. Policy: the tools

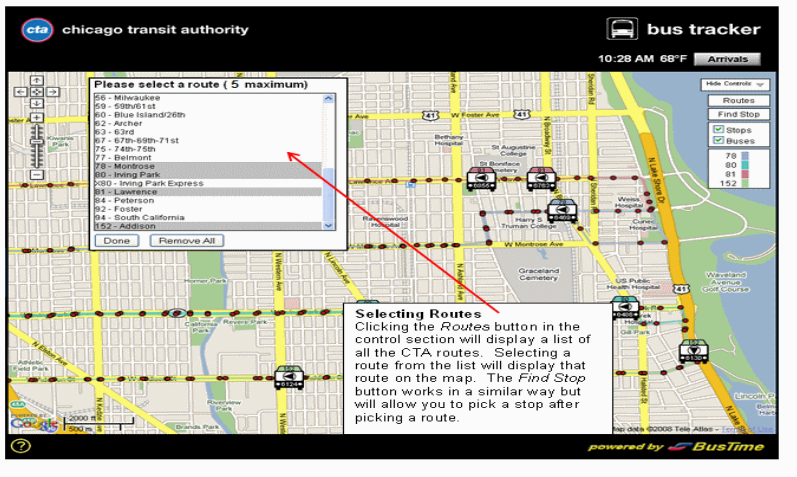
Soft policies and economic incentives

- Teleworking and teleshopping
  - The concept: through web communications, less trips may be demanded, as working and shopping may be from home
  - Despite the initial optimism, the potential of reducing trips is deemed as very modest
  - Rebound effect: teleworker may choose living far, therefore increasing the extension of trips.
  - Reduced scope in developing countries

5. Policy: the tools

Soft policies and economic incentives

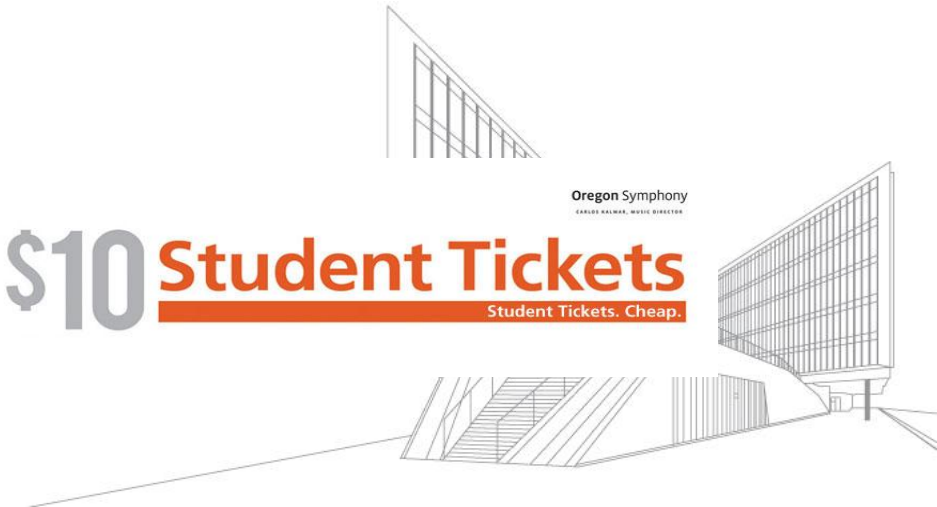
- Information and education
  - Increase awareness about environment and congestion
  - Information: smart driving, public transportation information
  - No conclusive evidence about the impacts, but it may contribute to “cultural change”.



5. Policy: the tools

Soft policies and economic incentives

- <u>Enhance accessibility</u>
  - Groups of population have difficulties to use transportation
  - Target: poor people, low income workers, students
  - Specially oriented subsidies to access public transportation



6. Policy: Sketching out some guidelines

Managing urban transportation requires a planning approach, due to externalities, huge sunk investment, instability of bus markets and coordination with land use.

There is not "one" solution; a strategy that blends wisely the tools at hand is to be devised.

It is uncontroversial that the use of the automobile must be limited, and that fuel consumption and environment standards must be enforced.

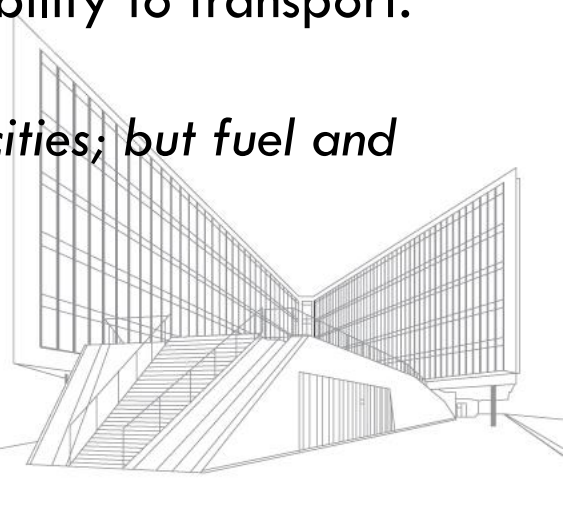
Guarantee universal access to transportation and improve information and awareness are also universal principles, although they have more impacts in larger cities.

Policy guidelines need to be quite specific; different urban areas present different problems and issues.

Policy: Sketching out some guidelines

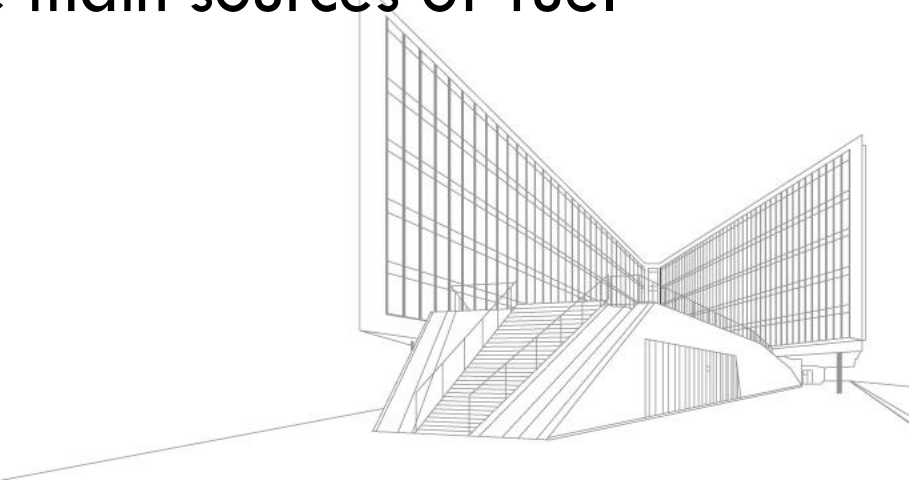
- Limited scope of policies for towns y medium size cities (up to 200,000-500,000 inhab.):
  - The basic road system conveys traffic with little congestion and at appropriate speeds.
  - Disadvantage of buses due to low frequencies and tortuous routes limit derivation from automobile.
  - Dilemma: two wheels development may damage the bus service, due to demand diversion, reducing bus competitiveness.
  - Main policy: compensation of differential accessibility to transport.

50% of world urban population lives in this class of cities; but fuel and emissions are quite in lower proportion.



Policy: Sketching out some guidelines

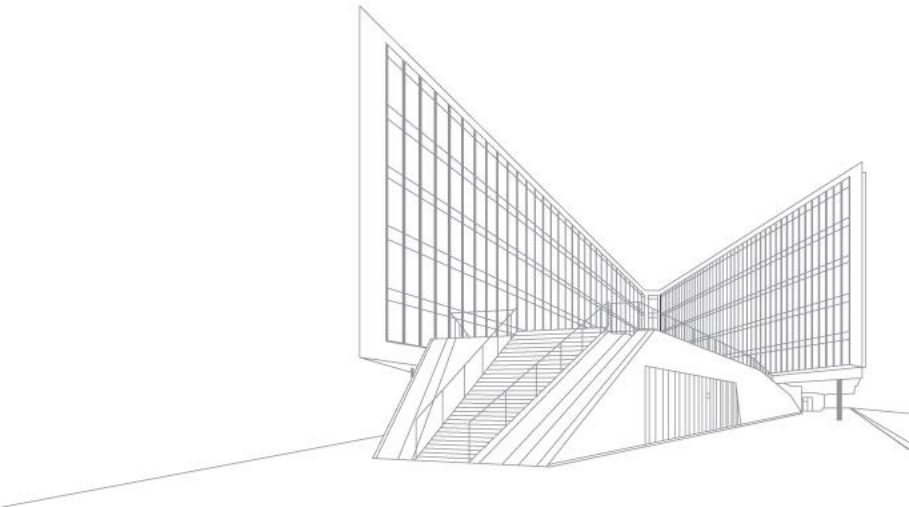
- Larger cities – around 1.000 cities across the world – deserve more ambitious and diversified policies. They belong to
  - High income countries – 15%
  - Middle income countries – 82%
  - Low income countries – 3%
- These areas are by large the main sources of fuel consumption and emissions.



Policy: Sketching out some guidelines

Large cities policies must differentiate three different segments:

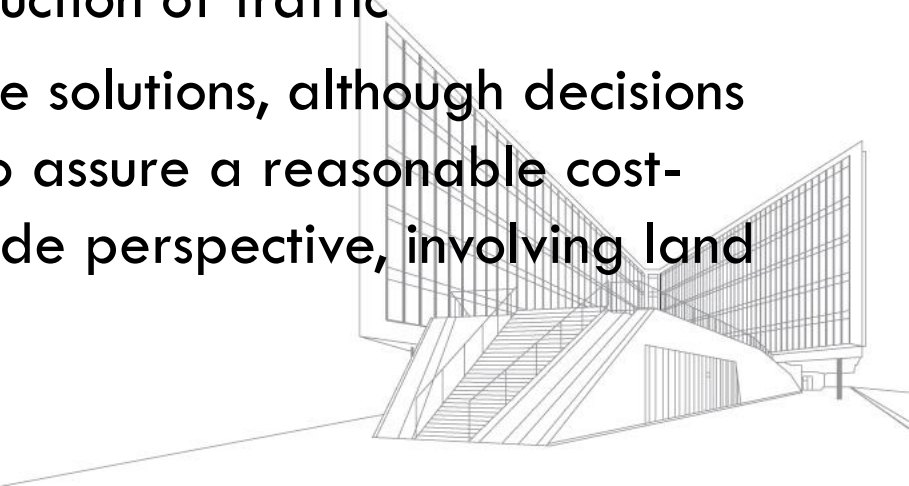
1. Concentrated cities in developed countries
2. Diffuse (low density) cities in developed countries
3. Cities in developing countries



Policy: Sketching out some guidelines

1. Concentrated cities in developed countries

- Diversion to public transport is possible, but mainly for commuting to the central areas (approx. 15-30% of total trips)
- Congestion fees are recommended, as well as parking fees (already in place). But congestion fees face political resistance. The traffic reduction to be expected is not very high, and it depends on the quality of public transportation.
- Tolling freeways may be innocuous, or lead to congestion of no tolled facilities, without any reduction of traffic
- BRT and metros are appropriate solutions, although decisions need a close scrutiny in order to assure a reasonable cost-benefit relationship (under a wide perspective, involving land use).



Policy: Sketching out some guidelines

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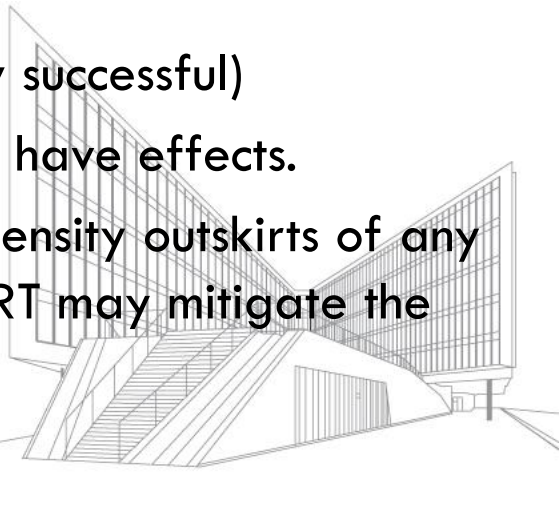
2. Diffuse (low density) cities in developed countries

- These cities mostly are not in a "critical" situation; congestion does not threaten its activities.
- A main problem is accessibility to transportation
- The issue is here fuel consumption and emissions, besides that in general are expensive cities regarding mobility.
- Diversion to public transportation is a difficult matter, as there is not density enough for mass solutions, and the competitiveness of the automobile is very high. Metro systems replacing freeways lanes are not a solution.
- The only device at hand is carpooling (not very successful)
- In the medium-long term, land use policies may have effects.
- Similar concepts and guidelines apply to low density outskirts of any great city, although availability of metros or BRT may mitigate the use of the automobiles



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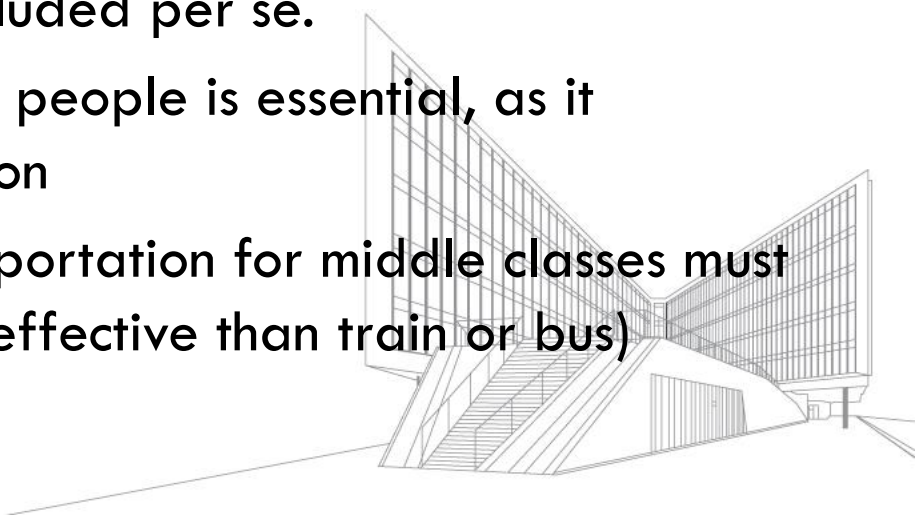
1. Cities in developing countries

- Policies for dense cities in general apply
- But there are important nuances:
  - Informality in bus services must be overcome, in order to move towards a more planned management – may be a contentious issue, as it may affect employment
  - BRT solutions may show more feasible than streetcars-LRT or metros in many cases, due to its lower cost; this does not mean LRT or metros should be precluded per se.
  - Assuring accessibility of poor people is essential, as it contributes to social integration
  - Attractiveness of public transportation for middle classes must be enhanced (metro is more effective than train or bus)



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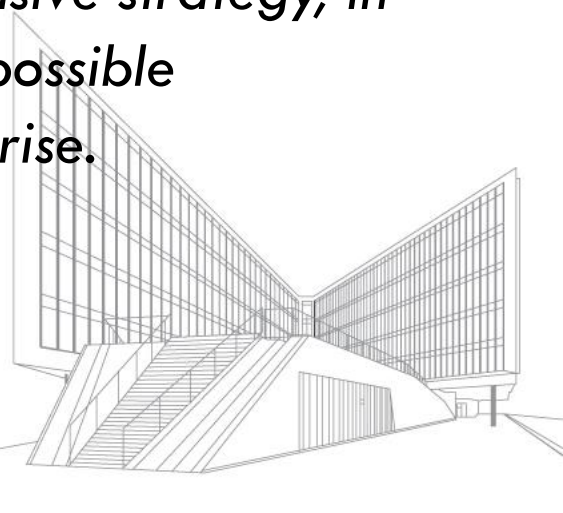
	Small towns and medium cities	Concentrated urban areas in developed countries	Diffuse urban areas in developed countries	Urban areas in developing countries
Provision of public services and facilities				
Facilities for cycling	+	++	-	++
Conventional bus	+	++	+	++
Bus rapid transit	-	++	-	++
Streetcars – Light Rail Transit	-	++	-	++
Commuter railroads	-	++	-	++
Metro rail systems	-	++	+	++
Increasing the capacity of the road system	-	++	++	++
Enforcement and regulations				
Enforcement of fuel consumption standards	++	++	++	++
Enforcement of emissions standards	++	++	++	++
Restrictions to vehicle circulation	-	+	-	+
Soft policies and economic incentives				
Congestion fees	-	++	-	
Parking fees in congested areas	-	++	-	++
Public transport subsidies	-	++	+	++
Public transport tariffs	-	++	+	++
Teleworking and teleshopping	-	+	+	+
Carpooling	-	+	+	+
Information and education	+	+	+	+
Enchance accesibility to transportation services	-	+	+	++

Conclusions

- *Urban transportation is a complex subject, because cities are complex and diverse units. It consumes huge quantities of nonrenewable resources and at the same time pollutes, both globally and locally. In part of the cities, urban transportation is also undergoing critical situations, due to congestion. In developing countries, poor population faces accessibility problems.*
- *A planning perspective is required.*
- *Different urbanization patterns may change substantially the performance of transportation, mainly the relative competitiveness of automobile and bus.*
- *A case by case approach must be in place*

Conclusions

- *Basic principles for a urban transportation policy.*
  - *Prevent congestion in large and dense cities and reduce fuel consumption and emissions of pollutants.*
  - *Assure access to transportation to all citizens.*
  - *Low density urbanization must be prevented*
  - *Use of automobile must be limited.*
  - *Metros and LRTs mainly for high income countries, while BRTs more convenient for developing countries.*
- *Policy tools must be applied through a comprehensive strategy, in order to enhance their advantages and mitigate possible contradictory effects, which are always likely to arise.*



FUNDACIÓN BARILOCHE

DESDE 1963

Contact information for further clarifications and queries:

amulle@infovia.com.ar

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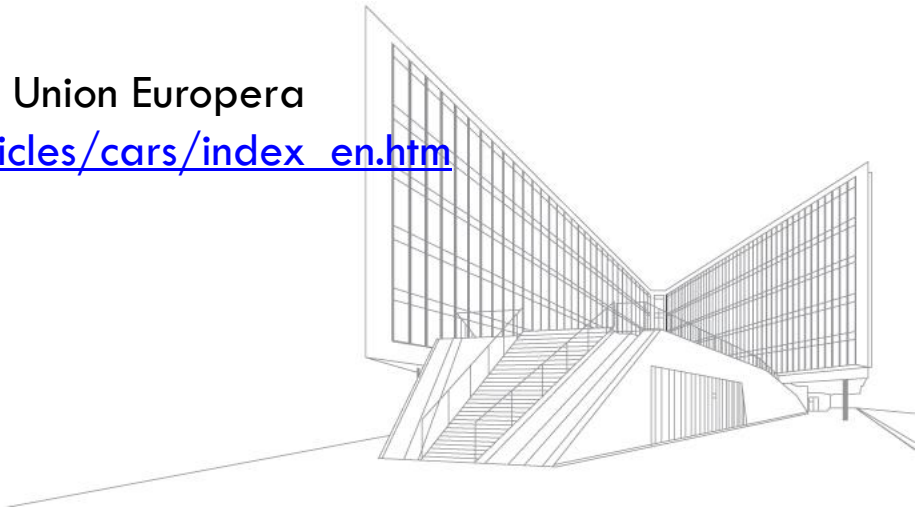

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