M3

SPECIAL

SPATIAL PLANNING and ENERGY for COMMUNITIES IN ALL LANDSCAPES

Mobilità, Trasporti ed Energia

MODULI PER LA FORMAZIONE A LUNGO TERMINE

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Mobilità, Trasporti ed Energia

1. Trasporti urbani ed efficienza energetica (1/2)
2. Trasporti urbani ed efficienza energetica (2/2)
3. Integrazione fra sistemi di trasporto ed ambiente urbano
4. Comunità locali energeticamente autosostenibili

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Mobilità, Trasporti ed Energia

1 Trasporti urbani ed efficienza energetica (1/2)

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Contenuto della presentazione

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- Strategie e strumenti per l'efficienza energetica nei trasporti urbani
- Modello di calcolo della dipendenza energetica dei trasporti urbani
- Alcuni casi studio

Mobilità Sostenibile

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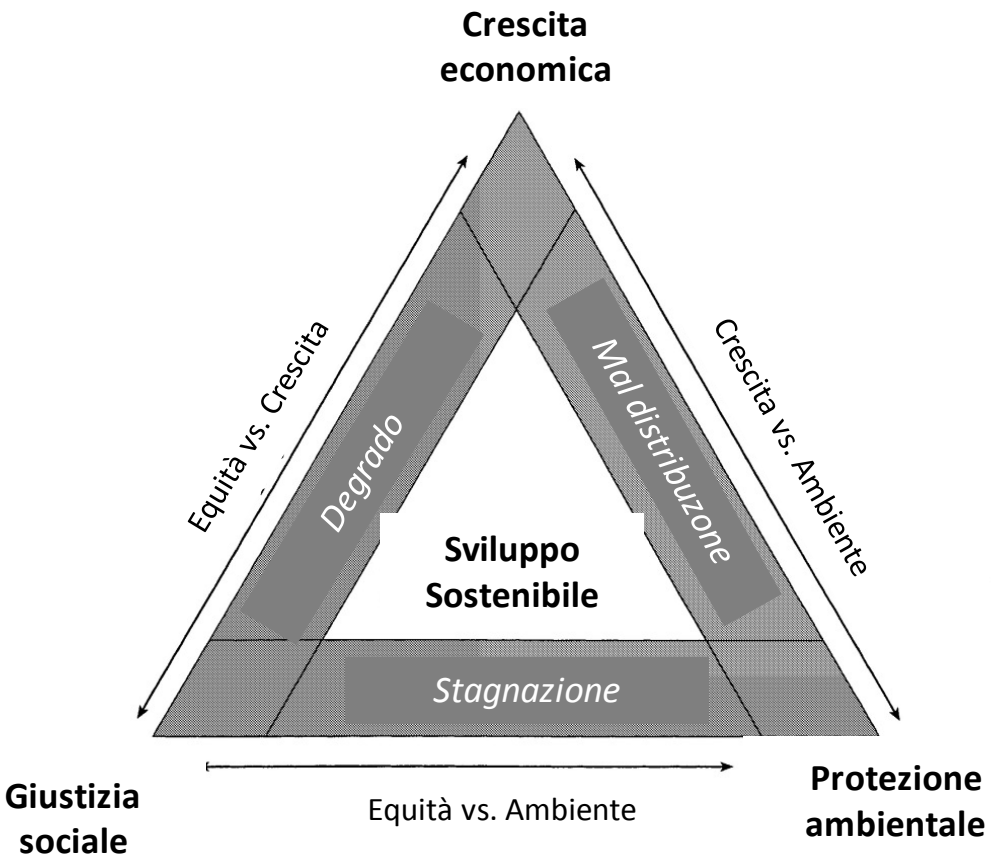
- Non mette in pericolo la salute della popolazione o degli ecosistemi e concilia la soddisfazione del bisogno di accessibilità con:
  - l'uso di **risorse rinnovabili** in un tempo uguale o inferiore a quello che esse impiegano per riformarsi;
  - l'uso di **risorse non rinnovabili** in misura uguale o inferiore al tasso di sviluppo di risorse alternative che siano rinnovabili.

Le tre dimensioni della sostenibilità

- Sociale
- Economica
- Ambientale



Feitelson, 2002

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Consumo di energia

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Trasporti ed energia in Europa

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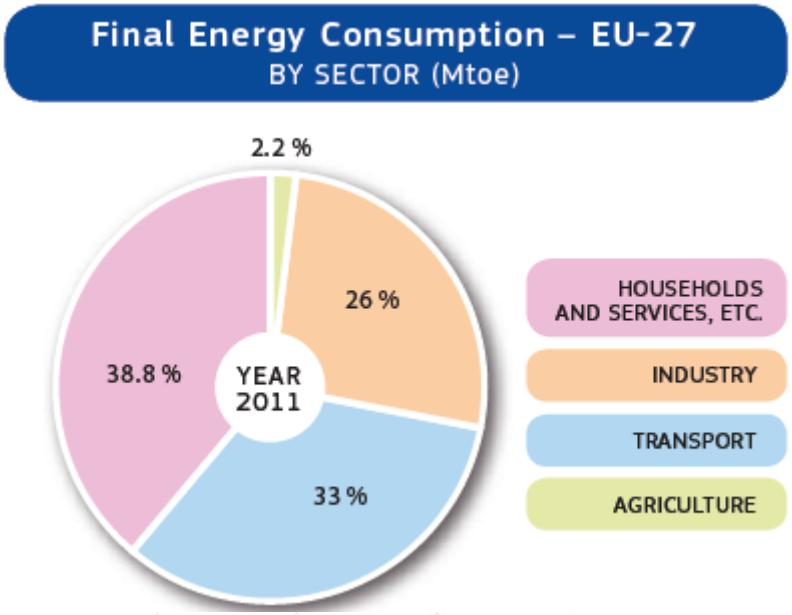
- I trasporti consumano 1/3 di tutta l'energia
- Usano il 70% del petrolio nell'UE.



EU Energy and Transport in Figures St atistical Pocket book 2013

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Trend crescita emissione CO2 per settore

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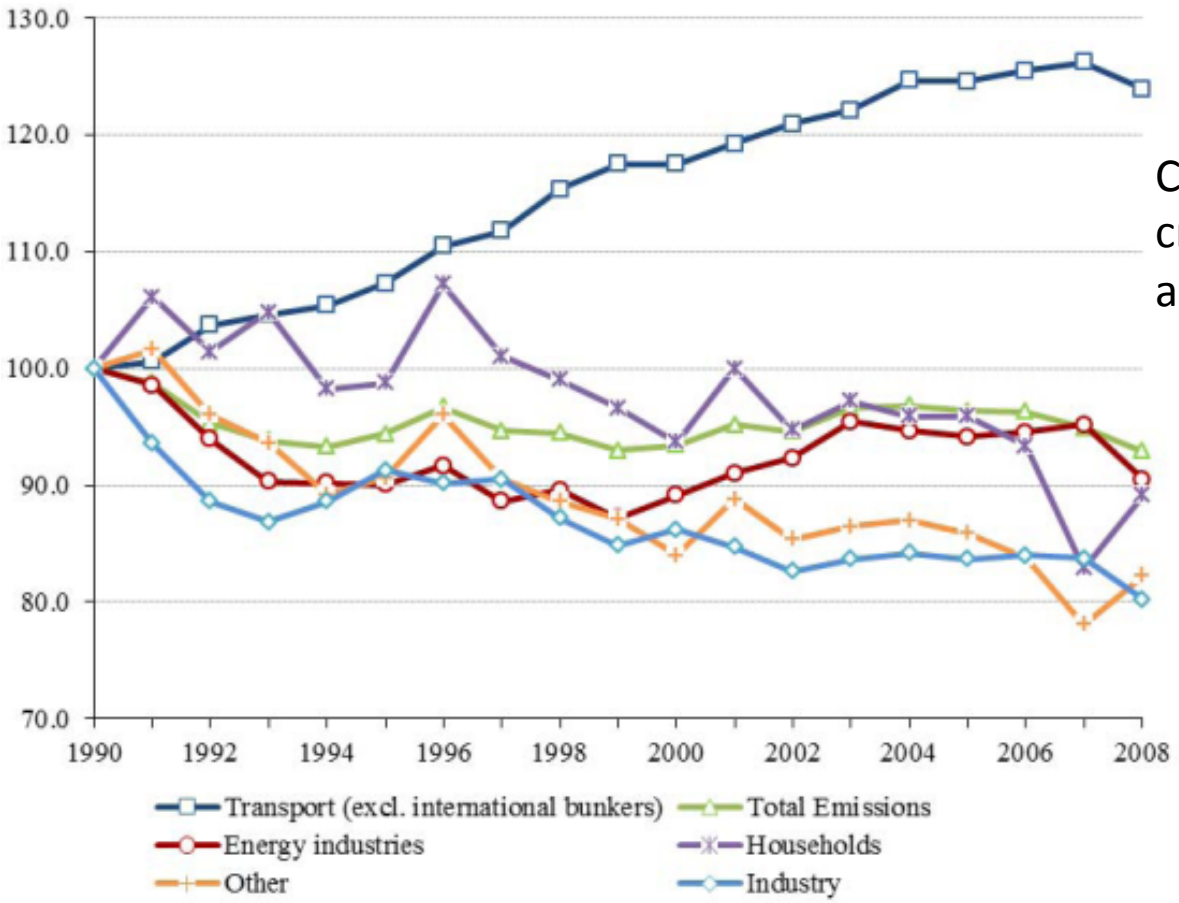

Consumi per trasporti crescono del 2.5% per anno dal 1971

EU Energy and Transport in Figures
Statistical Pocket book 2010

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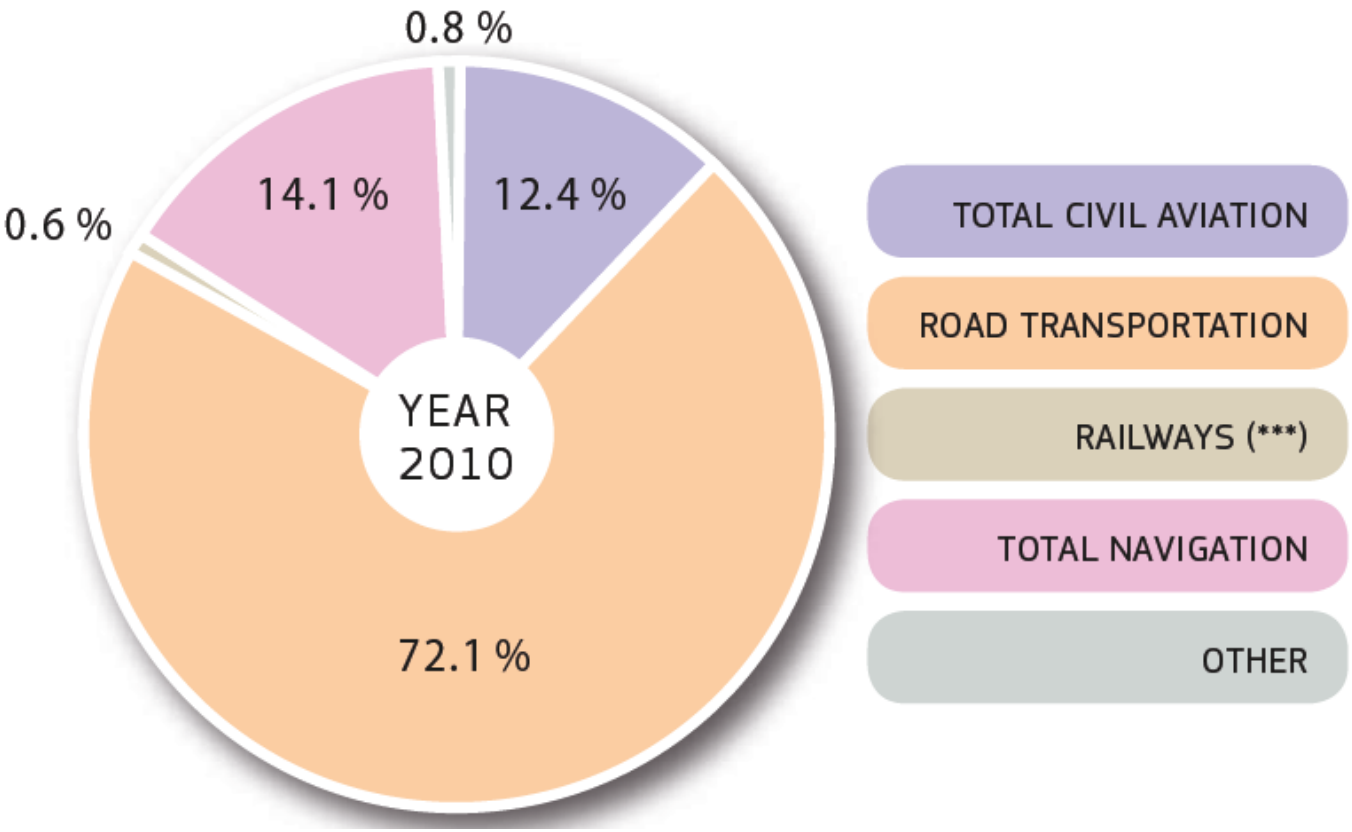
CO2 per modo di trasporto



Il trasporto stradale e quello aereo consumano rispettivamente il 60% e il 9% di tutto il petrolio

EU Energy and Transport in Figures St atistical Pocket book 2010

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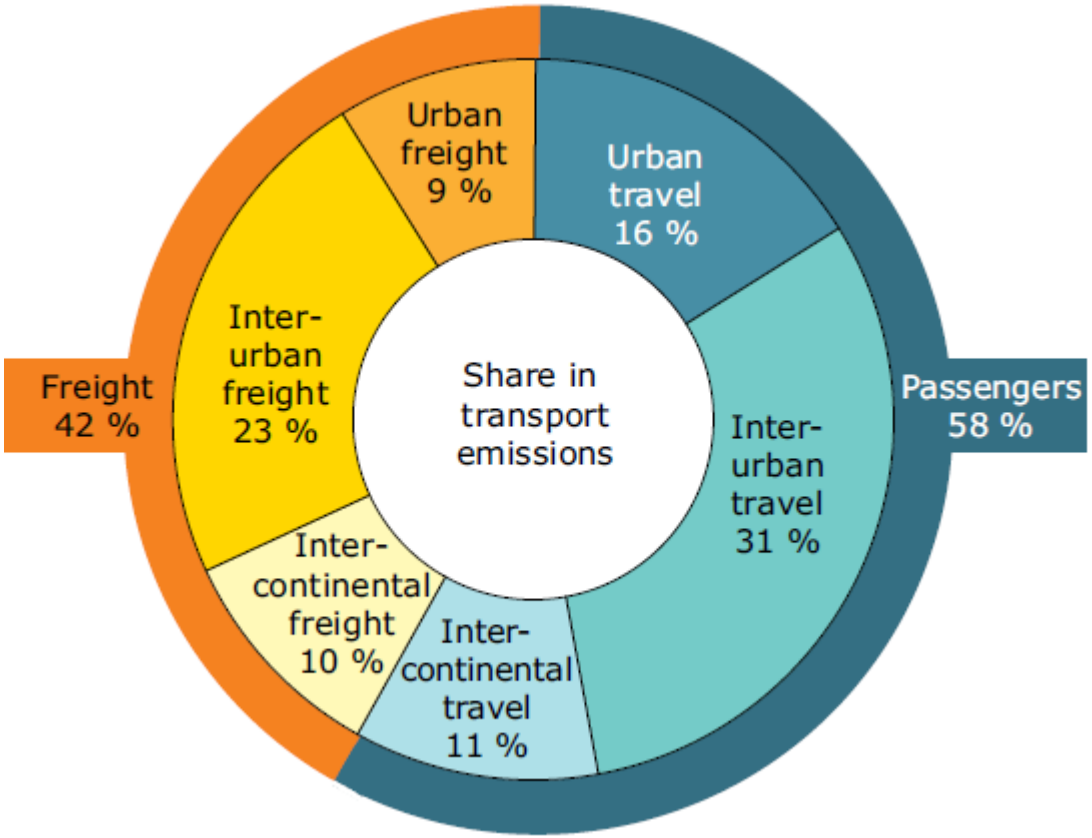
Ripartizione emissioni gas serra (EEA, 2013)



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Criticità dei trasporti

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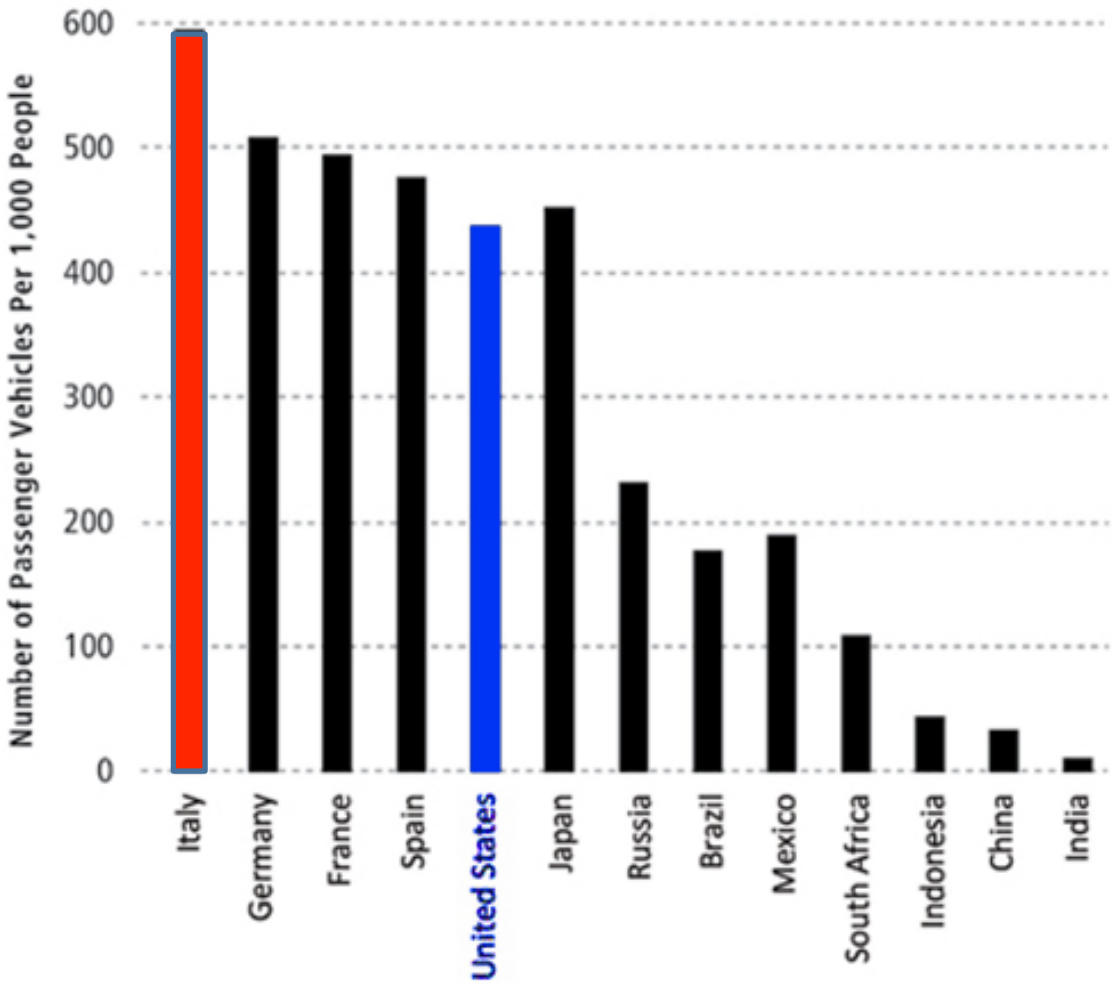
- Tasso di motorizzazione in Italia
- Squilibrio modale
- Spread Italia – Europa
- Inefficienza energetica automobile

Tasso di motorizzazione



http://www.theatlantic.com/2012

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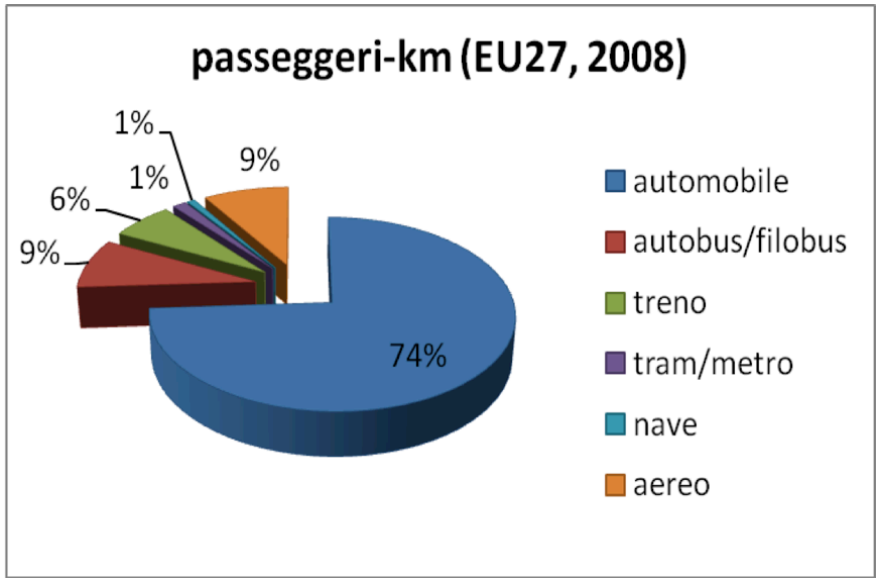
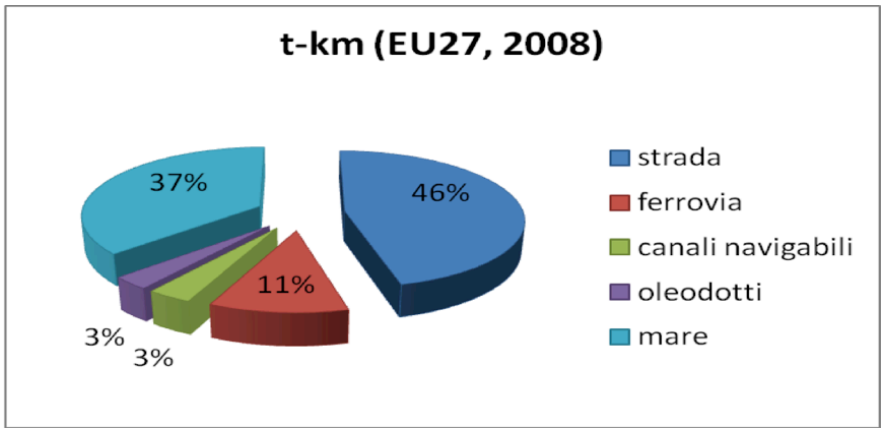
Ripartizione modale



passeggeri



merci

EC (2010). EU Energy and Transport in Figures - Statistical Pocket book 2010. doi: 10.2768/19814

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Spread Italia-Europa

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CITTA'	AUTO/100 ABITANTI
AOSTA	250
TRENTINO	117
L'AQUILA	79
PERUGIA	71
ROMA	71
CAGLIARI	69
TORINO	62
PALERMO	59
MILANO	57
NAPOLI	56
FIRENZE	54
BOLOGNA	52
GENOVA	48
MEDIA ITALIA	57

CITTA'	AUTO/100 ABITANTI
PARIGI	45
BARCELLONA	41
STOCCOLMA	38
VIENNA	38
LONDRA	36
BERLINO	35
MADRID	32
MEDIA UE27	33

Tasso di motorizzazione nelle principali città in Europa ed in Italia (Fonte: Cascetta, 2013)

	Modalità automobile %	Modalità Trasporto Collettivo %	Modalità Ciclabile + Pedonale %
Parigi	17	33	50
Amsterdam	38	20	42
Madrid	38	38	24
Berlino	31	26	43
Roma	67	28	5
Milano	52	36	12
Media UE 27	43	32	25
Media Italia	62	23	15

Ripartizione modale nelle città con più di 250 mila abitanti (Fonte: Cascetta, 2013)

Consumo unitario di energia dei diversi modi di trasporto

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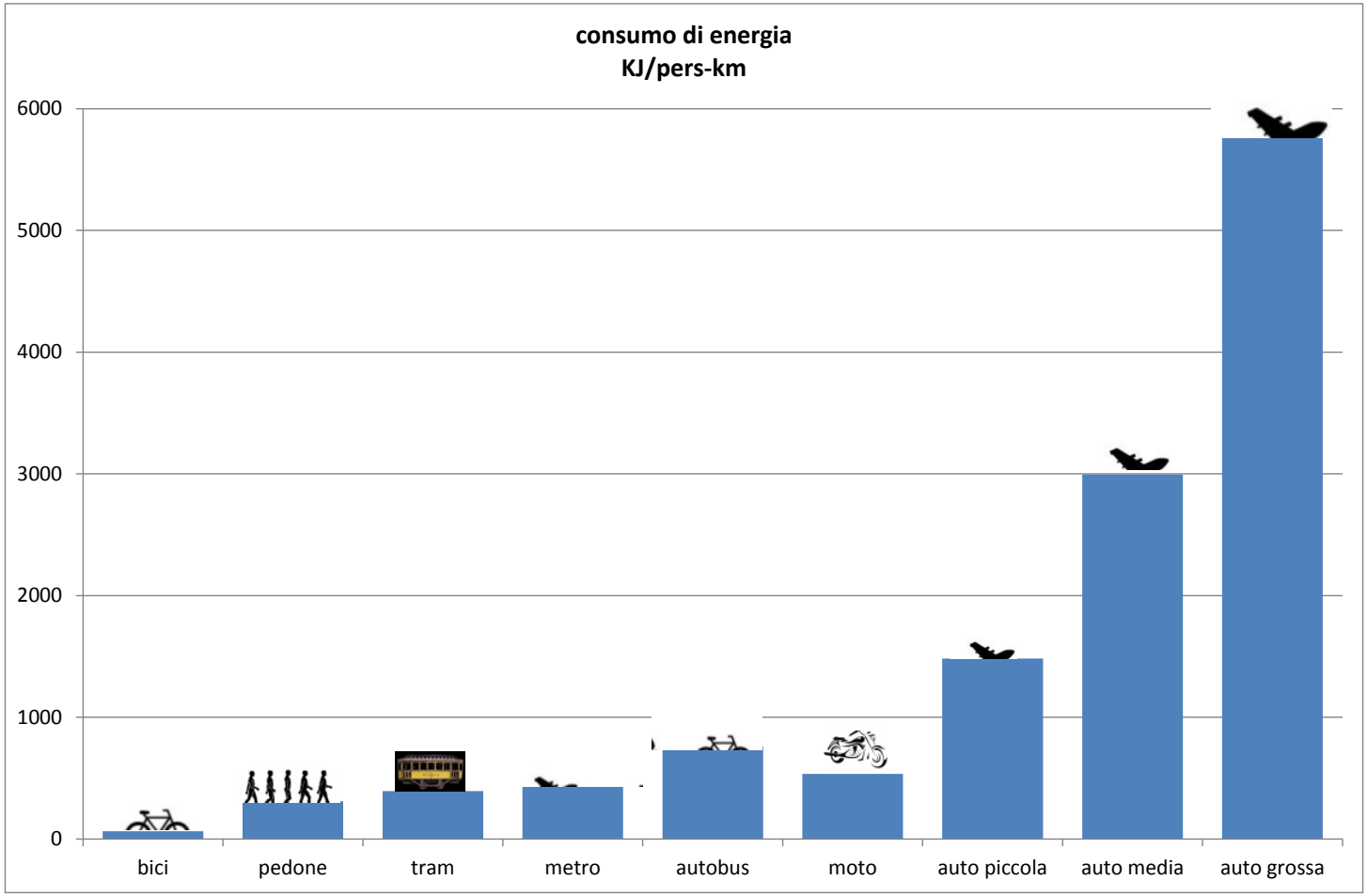

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Inefficienza energetica dell'automobile

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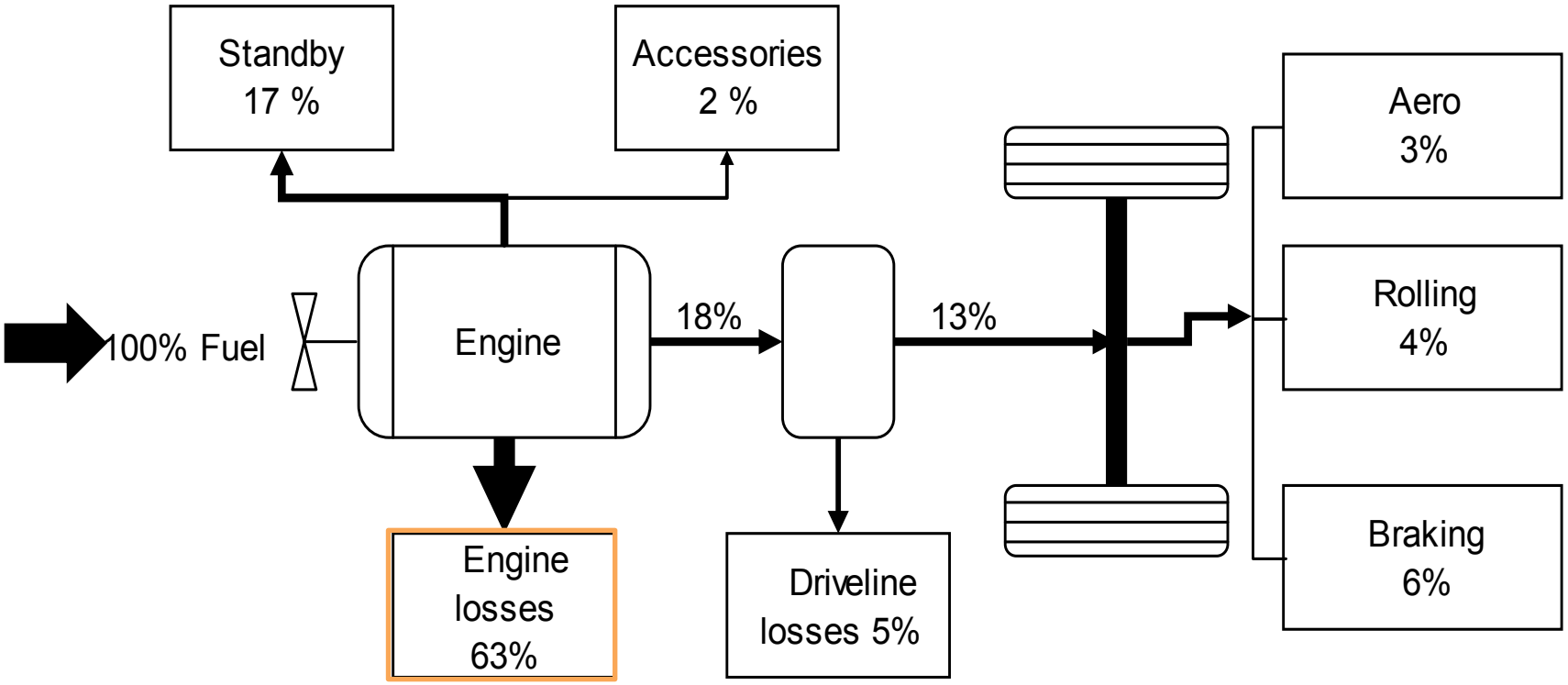

Meno del 2% dell'energia consumata diventa trasporto utile

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STRATEGIE

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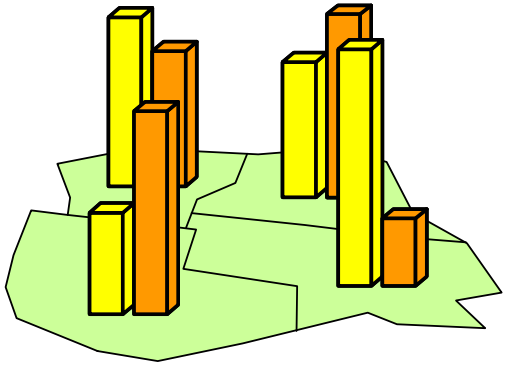
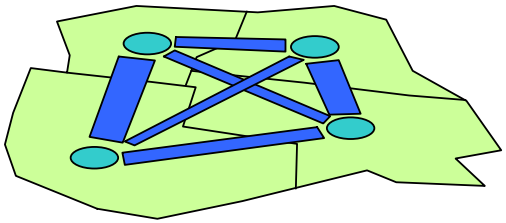
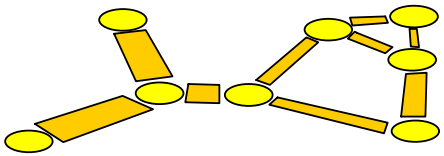
Come si produce il traffico



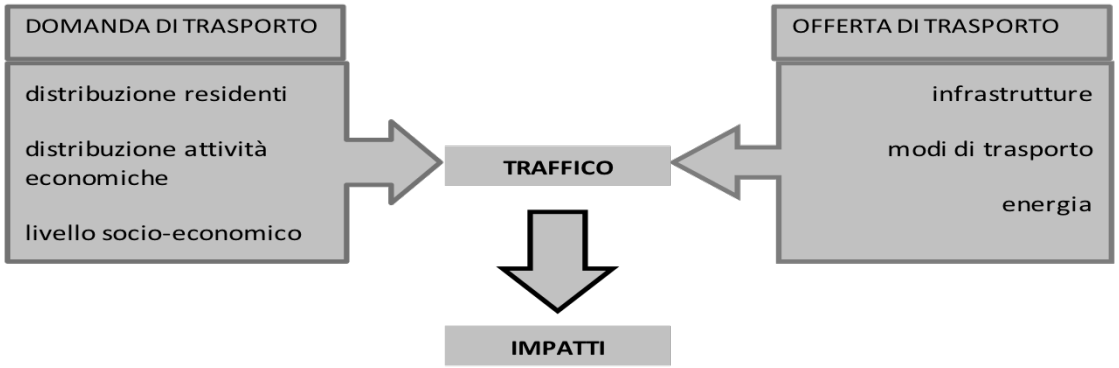
Land Use



Spatial Interactions



Transportation Network



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Come ridurre il consumo di energia nei trasporti

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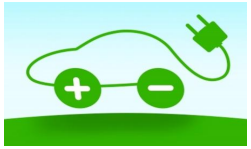

Distribuzione residenti

Distribuzione attività

Efficienza energetica trasporti

$$E_t[kWh] = Persone[pax] \times \text{Distanza}[km] \times \frac{Consumo_Veicolo[kWh/km]}{Capacità_Veicolo[pax] \times Fattore_Carico[\%]}$$

Tecnologia trasporti

Efficienza uso trasporti

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Efficienza Energetica Globale

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RIDURRE	CAMBIARE	MIGLIORARE
Efficienza del territorio	Efficienza dei trasporti	Efficienza dei veicoli
• Integrare uso territorio/trasporti • Smart Growth • Transit Oriented Development • **(pax-km)**	• Favorire l'uso dei modi di trasporto a basso impatto e consumo unitario • **(veic/pax)**	• Tecnologie per ridurre l'energia per km (TTW) e usare carburanti puliti (WTT) • **kWh/veic-km**
Pianificazione territoriale	Pianificazione dei trasporti	Innovazione tecnologica

$$E_t[kWh] = Persone[pax] \times Distanza[km] \times \frac{Consumo_Veicolo[kWh/km]}{Capacità_Veicolo[pax] \times Fattore_Carico[\%]}$$

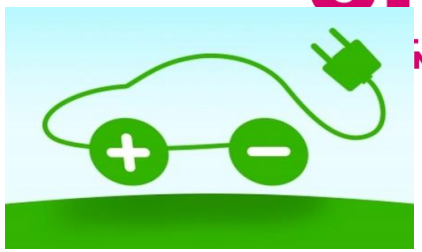
Ambiti

Pianificazione urbanistica

- Riduce l'esigenza di spostarsi
- Riduce la lunghezza degli spostamenti

Pianificazione dei trasporti

- Riduce l'uso dei modi di trasporto inefficienti
- Aumenta il fattore di riempimento dei veicoli



Innovazione tecnologica

- Migliora l'efficienza energetica dei veicoli
- Migliora la qualità ambientale dei carburanti

$$E_t[kWh] = Persone[pax] \times Distanza[km] \times \frac{Consumo_Veicolo[kWh/km]}{Capacità_Veicolo[pax] \times Fattore_Carico[\%]}$$

STRUMENTI

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PIANIFICAZIONE

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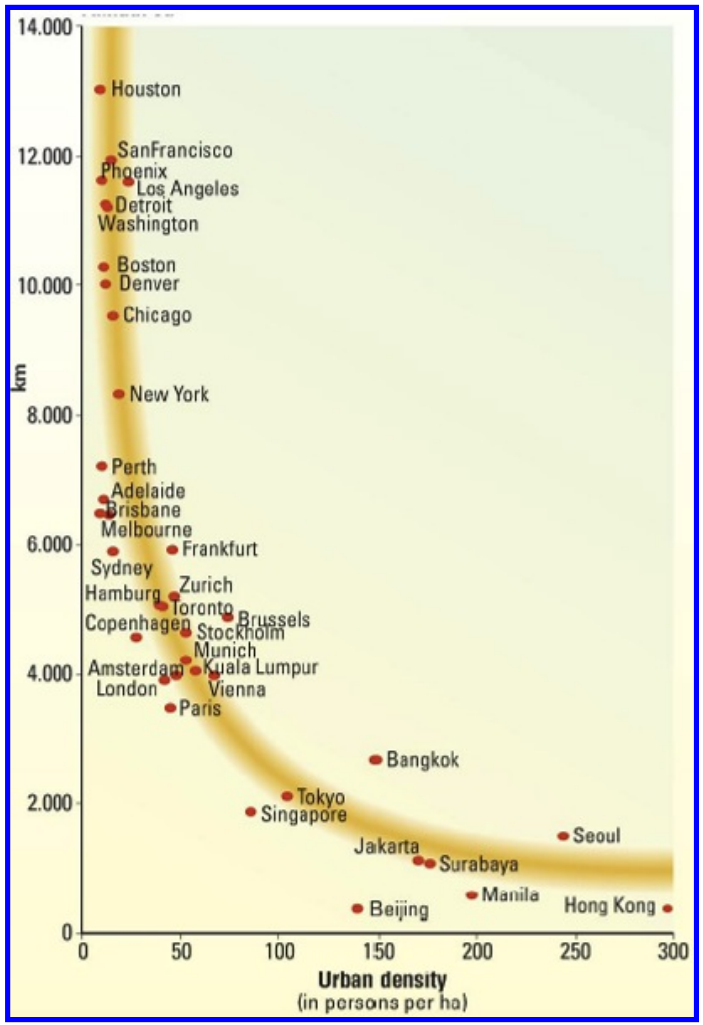

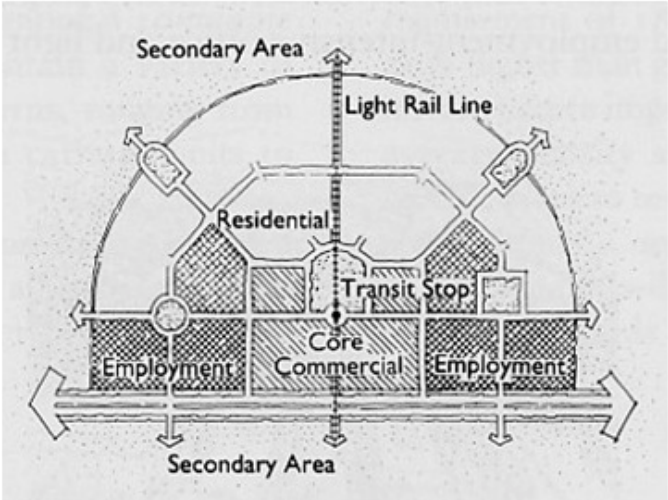

Smart Growth

Density, Diversity, Design, Destination, Density

Transit Oriented Development

Green Infrastructures

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REGOLE

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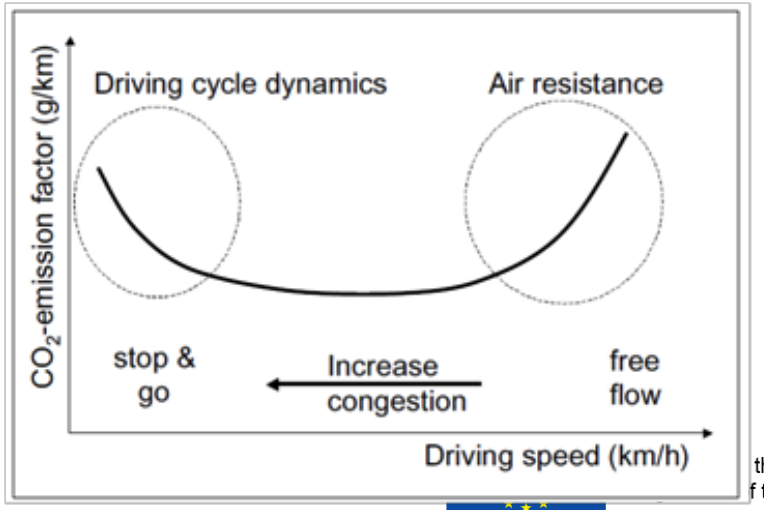
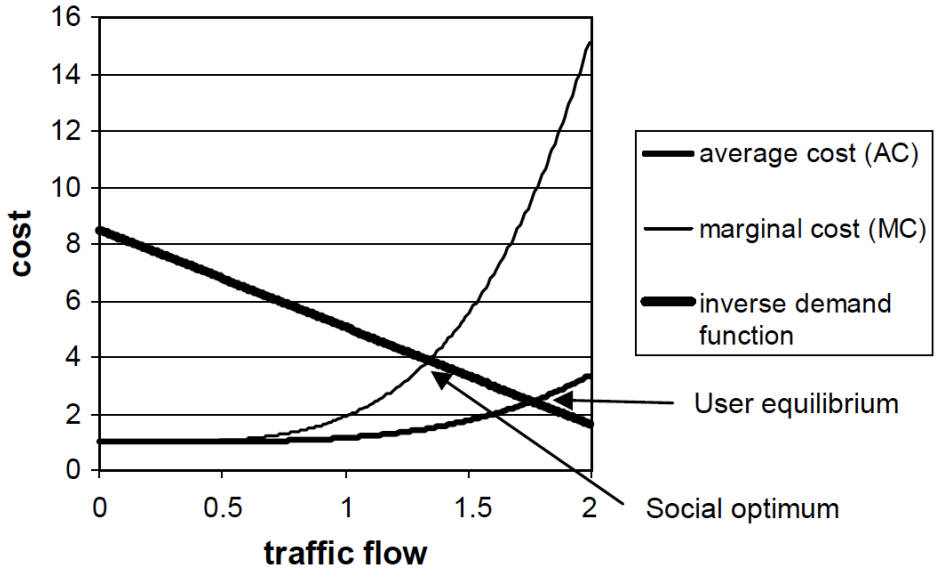
- Aree pedonali
- ZTL
- Zone 30
- Isole Ambientali
- Parking management



the Intelligent Energy Europe
f the European Union

ECONOMIA

- Internalizzare costi mobilità
- Road pricing
- Park pricing
- Carbon tax
- Pay-as-you drive insurance
- Chi inquina paga



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Road Pricing ICLEI, 2011

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City/scheme	Traffic % change	Traffic notes	CO_2% change	CO_2 notes
Bologna	-23%	Access reduction during charging hours on a working day, 2004-2006	Not available	
Durham	-85%	From over 2000 to approximately 200 vehicles per day	Not available	
London	-16%	% change in vehicles, 2006 versus 2002 during charging hours	-16%	Change between 2002 and 2003
Milan	-14%	Decrease in vehicles accessing the Ecopass Zone, 2007 to 2008	-14%	Change after first nine months of operation
Rome	-18%	From 80,000 to 72,000 vehicles, 2000 to 2005	-21%	Change in mean values between 2001 and 2004

INFORMARE

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Campagne di sensibilizzazione

Partecipazione pubblica

Addestramento alla guida sicura ed ecosostenibile

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TECNOLOGIA

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Efficienza energetica dei veicoli

- -20÷40% consumi entro il 2050

Qualità dei carburanti

- Ridurre le emissioni di CO_2

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TECNOLOGIE ITS

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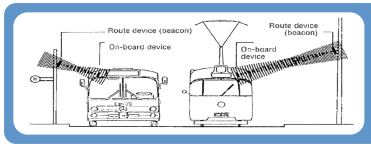


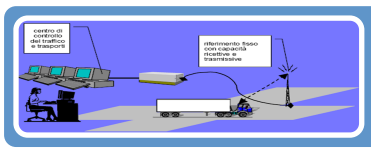
la gestione del traffico e della mobilità (*gestire e ottimizzare, non costruire*)

la gestione del trasporto pubblico

l'informazione all'utenza (*essere informati per scegliere bene*)

il controllo avanzato del veicolo (aumento della sicurezza e della capacità di traffico)

la gestione delle emergenze



la gestione delle flotte e del trasporto merci

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SMART CITY

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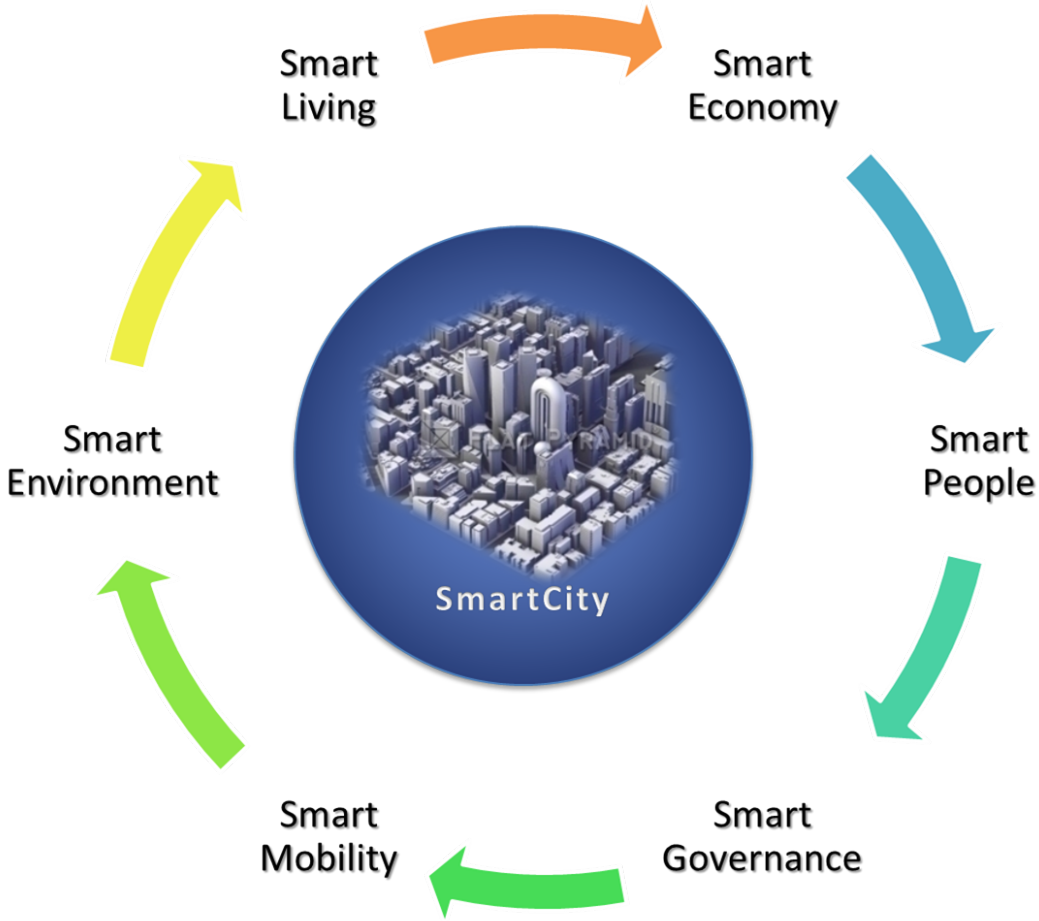

- Telelavoro
- Telebanking
- Teleconferenze
- Acquisti on line
- ..
- ..

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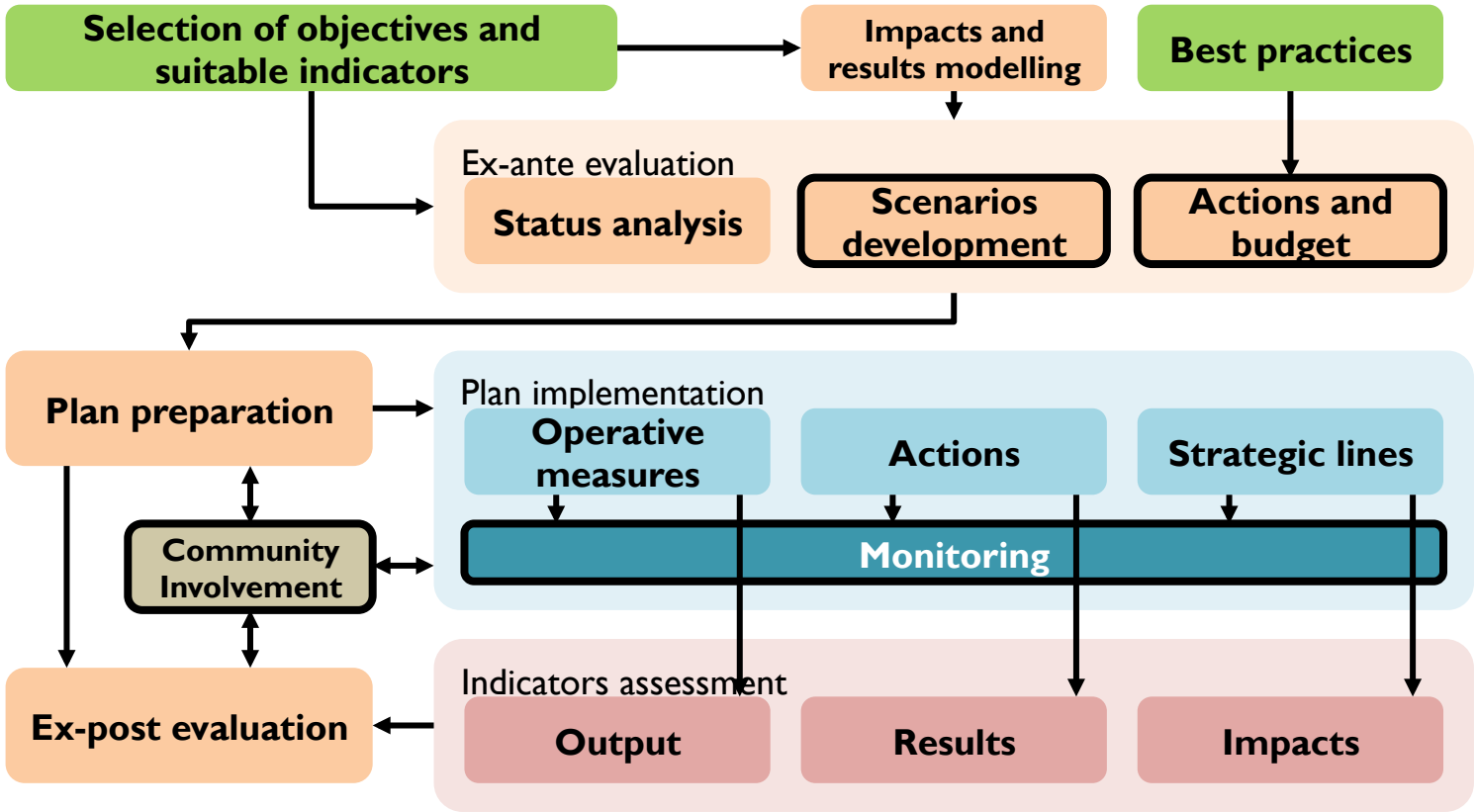
PIANI DI AZIONE PER LA MOBILITÀ SOSTENIBILE (SUMP)



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Mobilità vs Accessibilità

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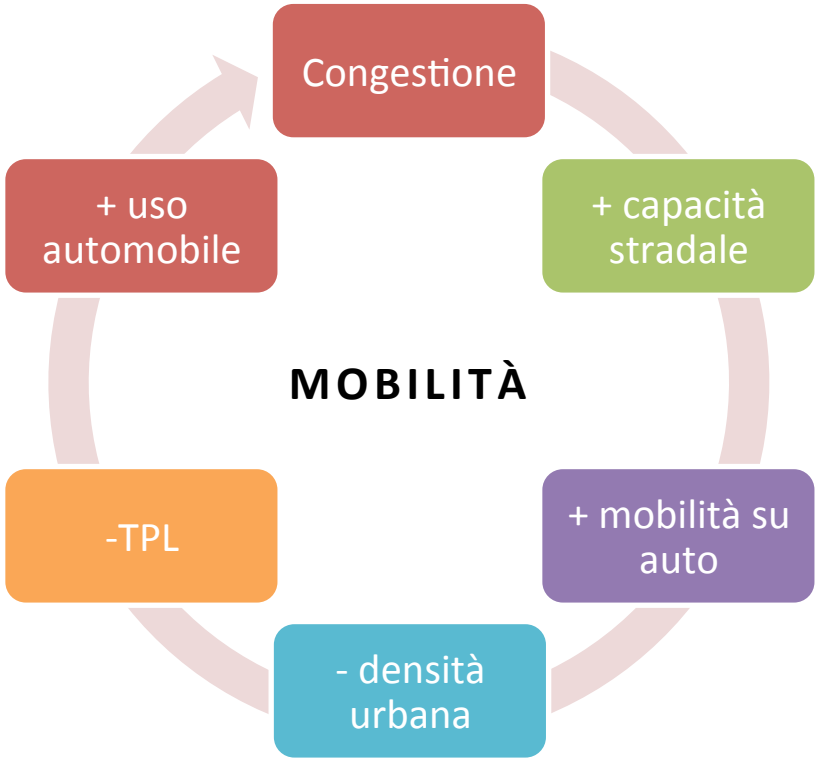

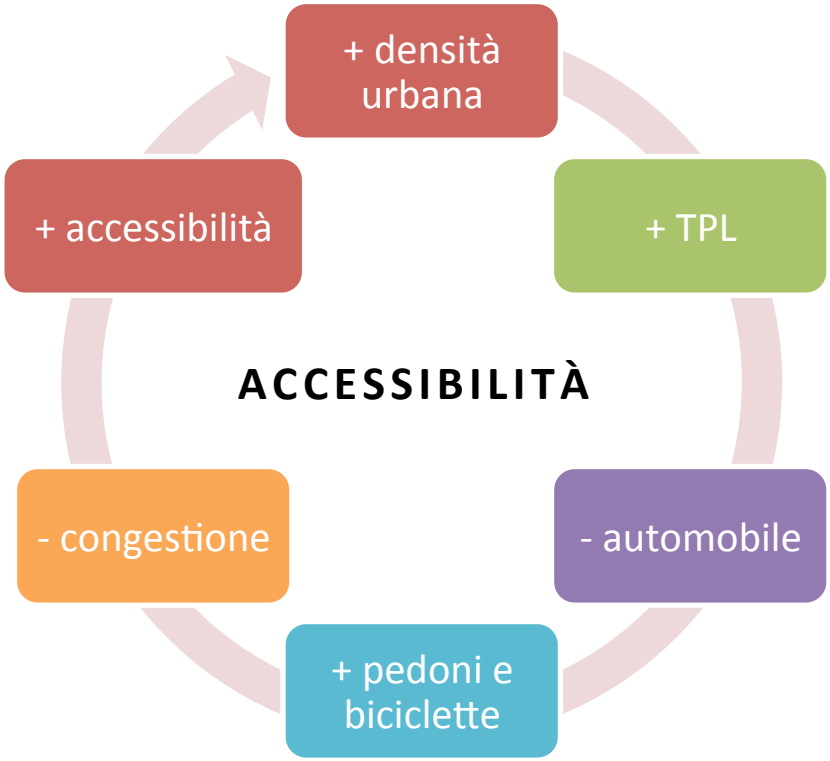

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Pianificazione integrata trasporti/ territorio

Impatto della pianificazione dei trasporti sul territorio

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I grandi sistemi ferroviari suburbani

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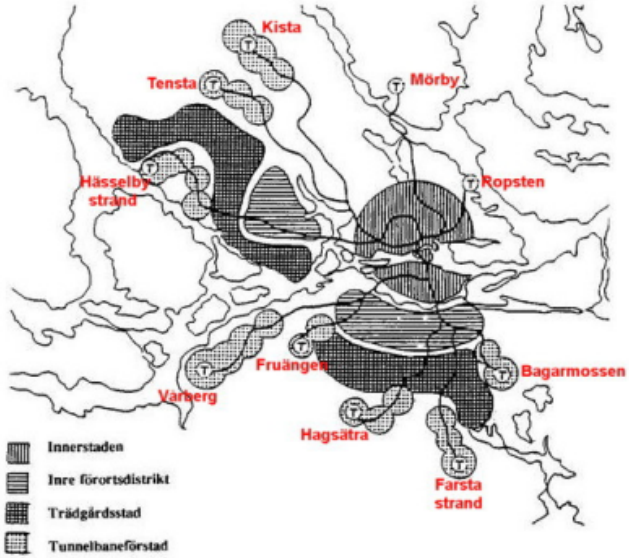
General Plan of Stockholm, 1952



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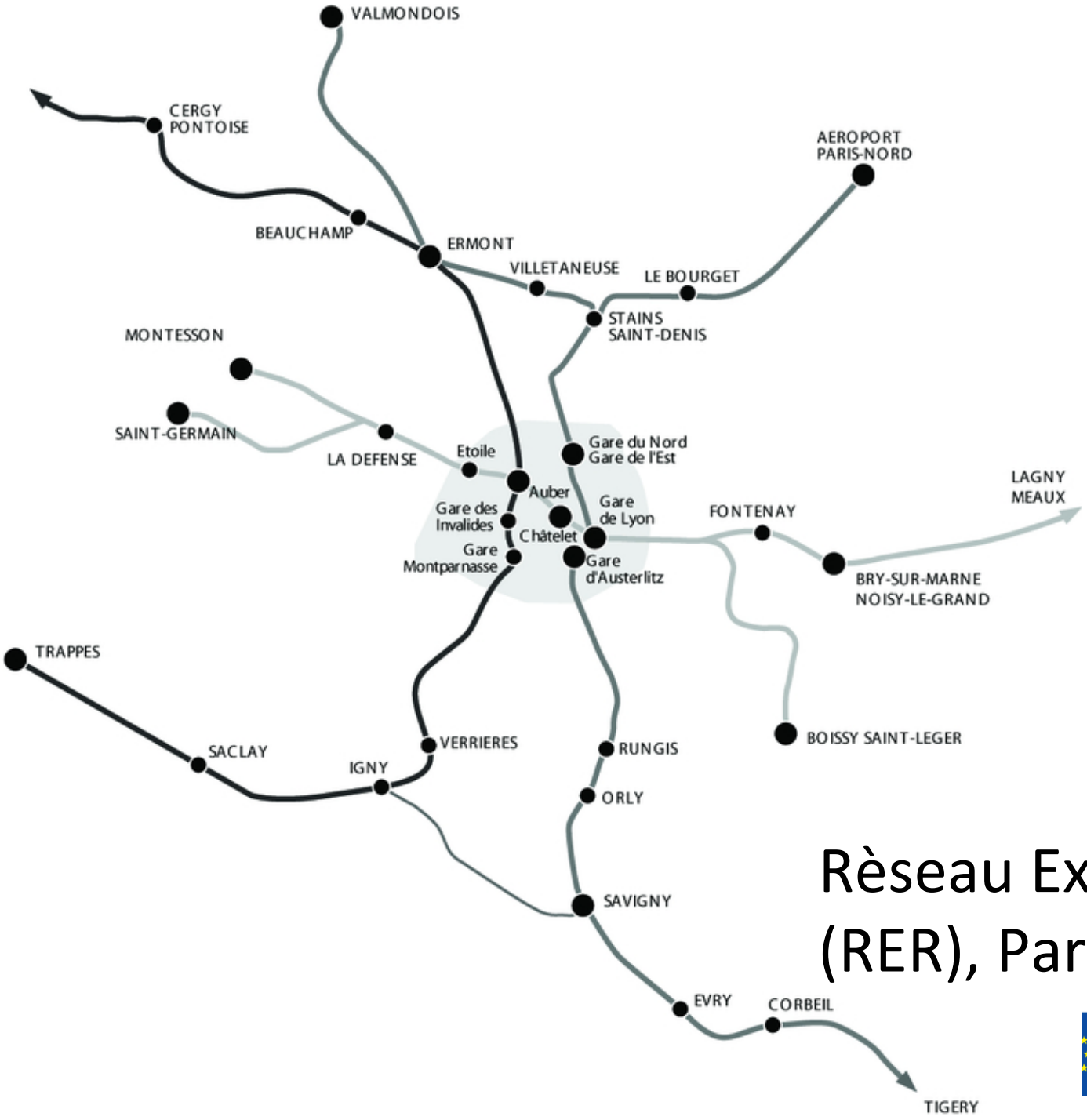

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Rèseau Express Regional (RER), Paris 1965

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Finger Plan Copenhagen, 1947

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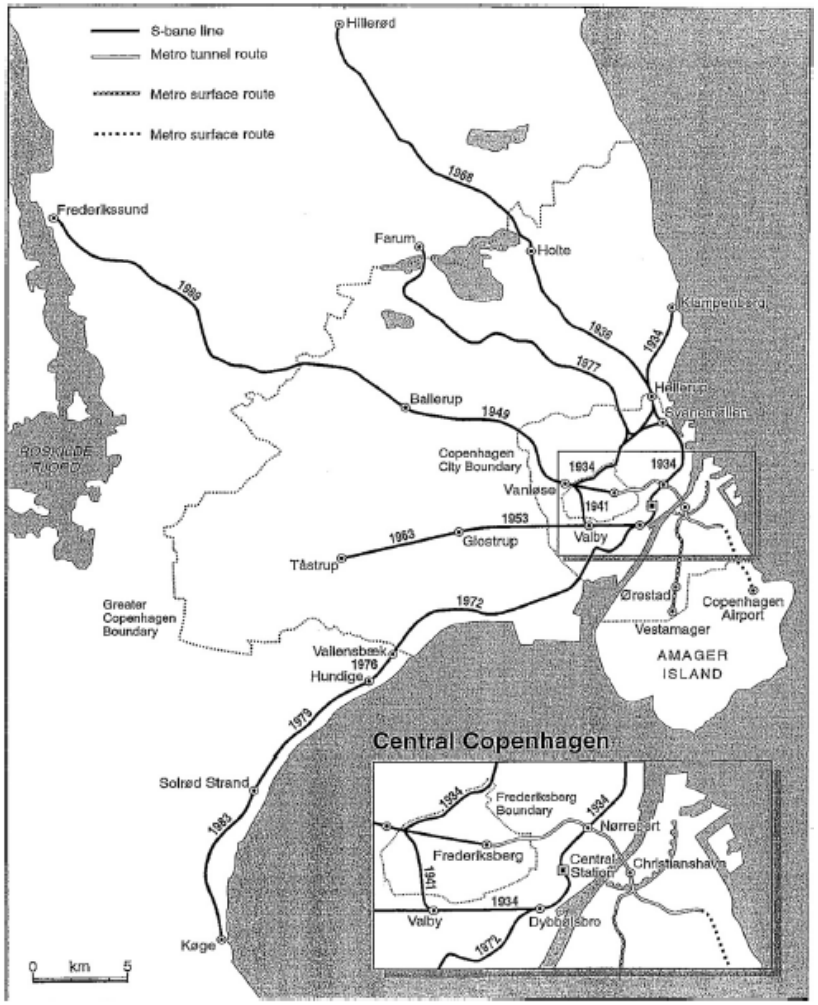

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Stadt-Schnellbahn (S-Bahn) di Berlino

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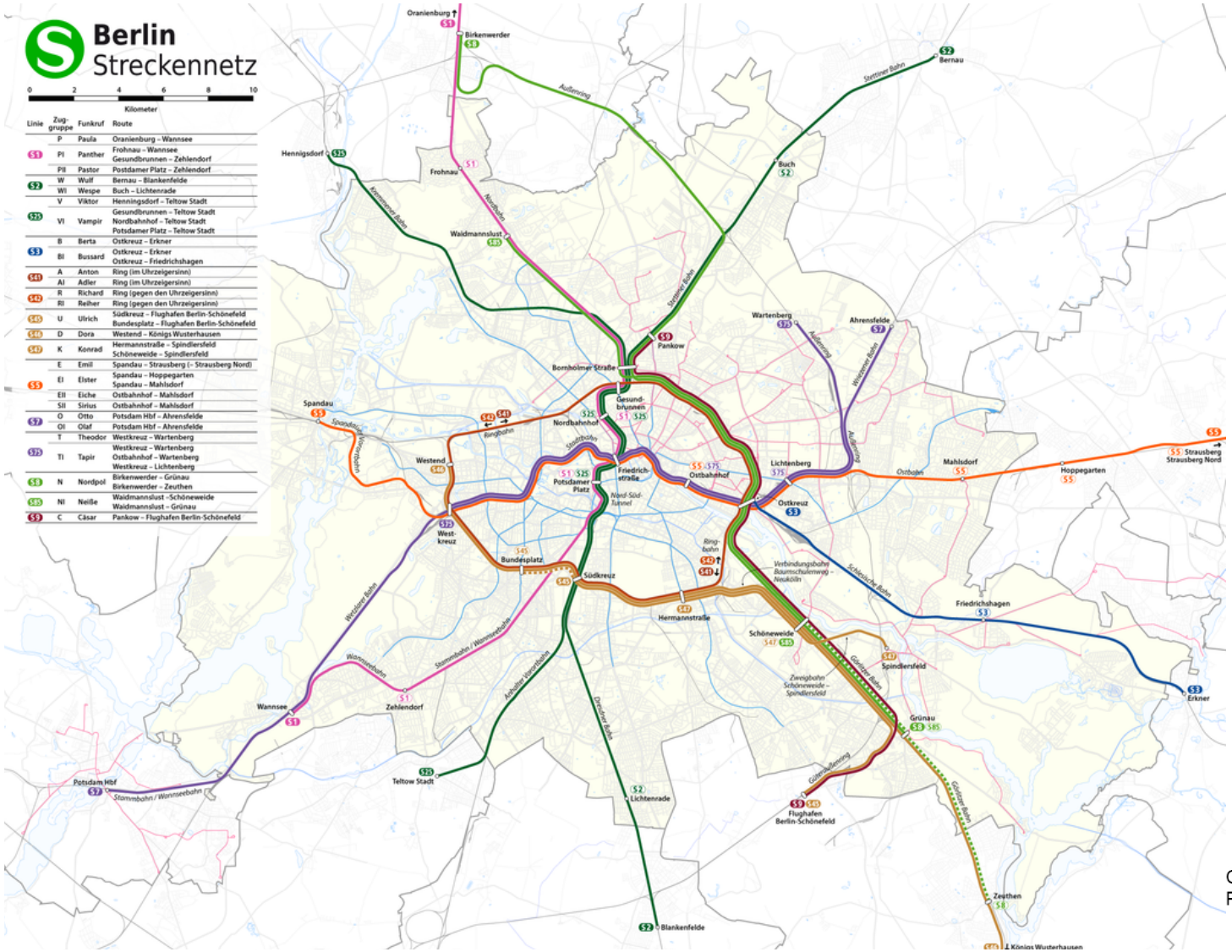

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La riscoperta delle reti tranviarie

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Rete tranviaria in Europa e in Italia

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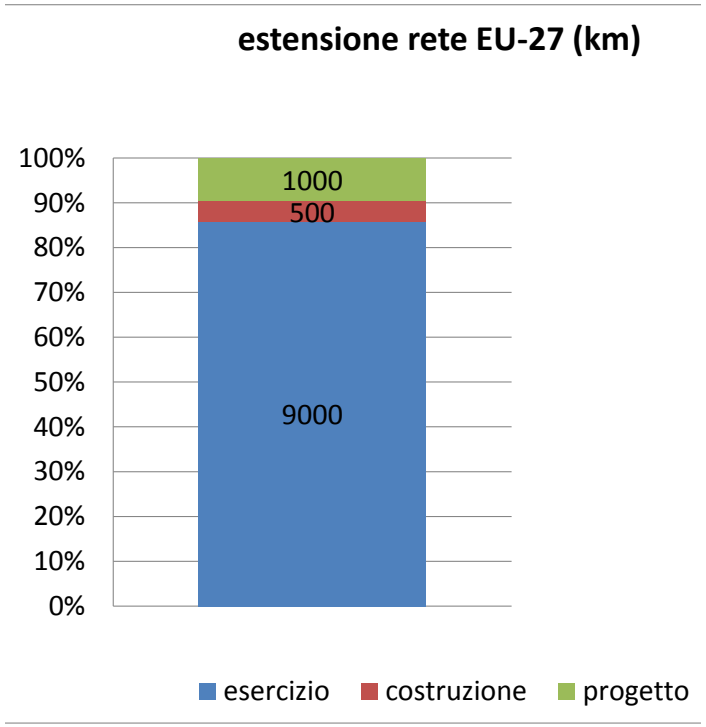

Gattuso, 2013

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- Vauban, Freiburg
- Germania
- Francia
- Palermo

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Il BRT

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Pianificazione integrata trasporti/ territorio

Impatto delle scelte urbanistiche sui trasporti

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Distanze degli spostamenti e uso dell'auto

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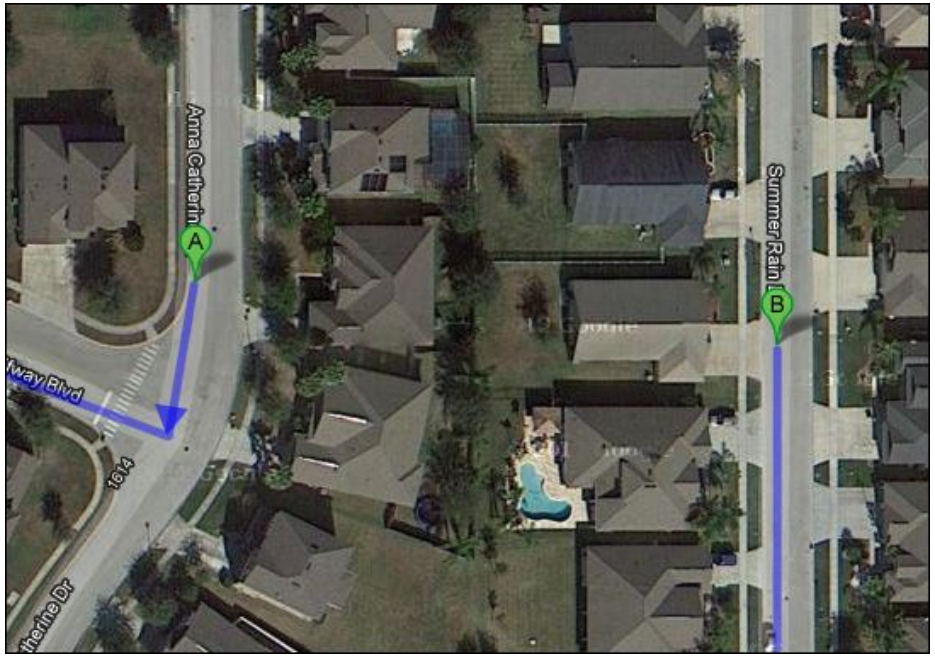

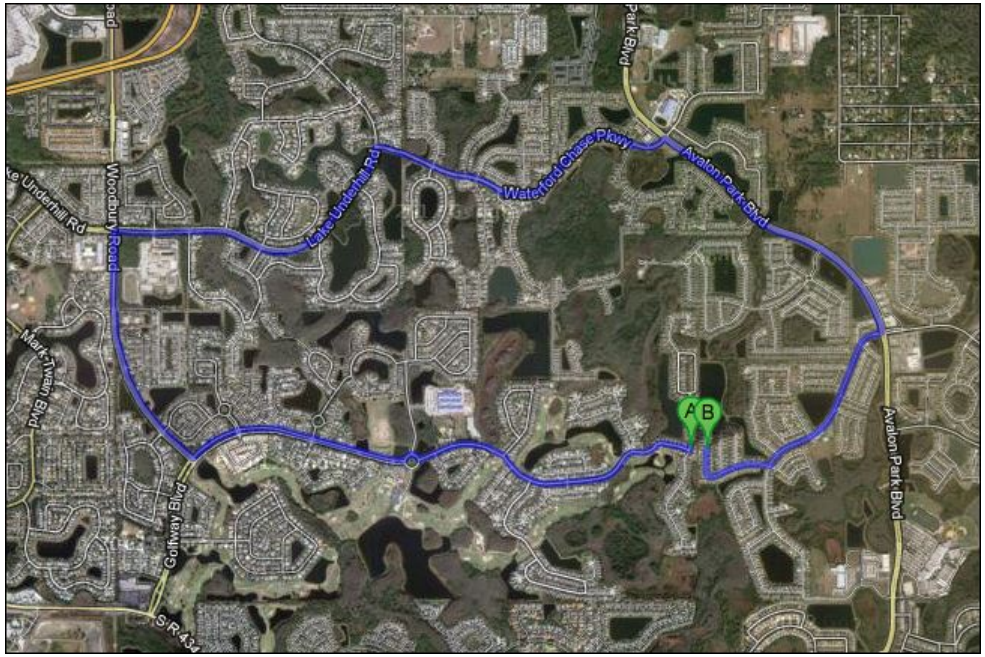

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Densità urbana ed energia trasporti

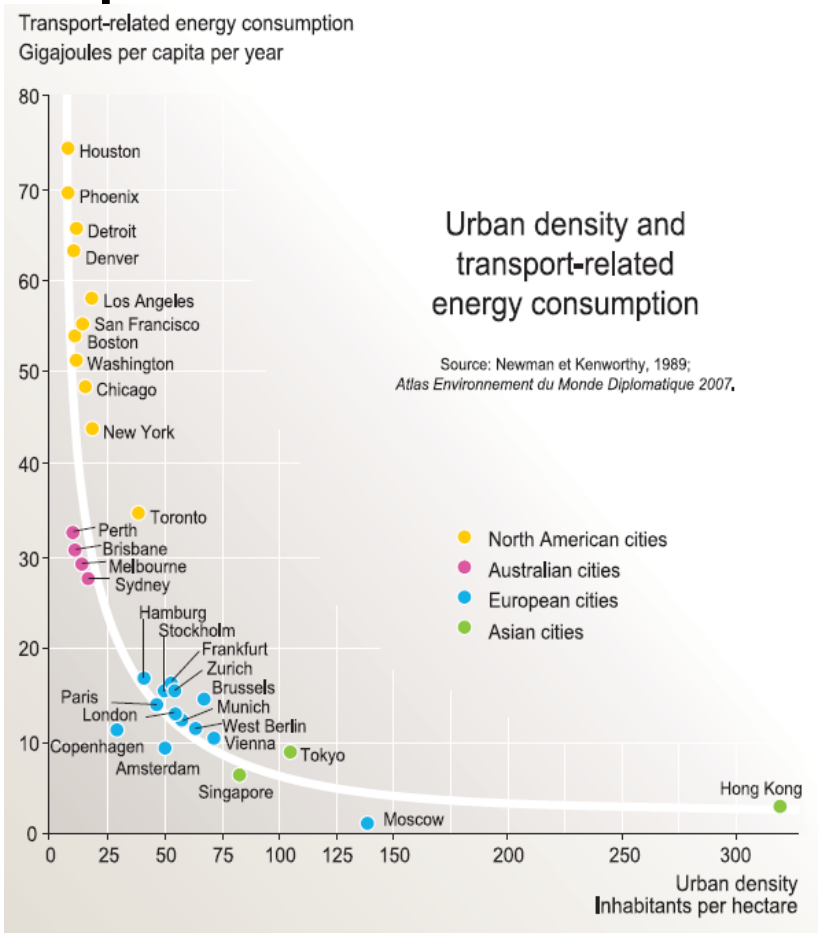

Figure 1 : The Newman and Kenworthy hyperbola: Urban density and transport-related energy consumption

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Smart Growth

SMART GROWTH PRINCIPLES

Mix Land Uses

Take Advantage of Compact Building Design

Create a Range of Housing Opportunities and Choices

Create Walkable Neighborhoods

Foster Distinctive, Attractive Communities with a Strong Sense of Place

Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas

Strengthen and Direct Development Towards Existing Communities

Provide a Variety of Transportation Choices

Make Development Decisions Predictable, Fair and Cost Effective

Encourage Community and Stakeholder Collaboration in Development Decisions

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Transit Oriented Development

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- Concentrare lo sviluppo urbano attorno ai nodi principali del trasporto pubblico è considerato uno degli strumenti più efficaci di riduzione della dipendenza dall'automobile.

- Calthorpe definisce il TOD come "una comunità con usi misti del territorio entro una media di 600 metri a piedi da una fermata/ stazione del TPL e dell'area commerciale."

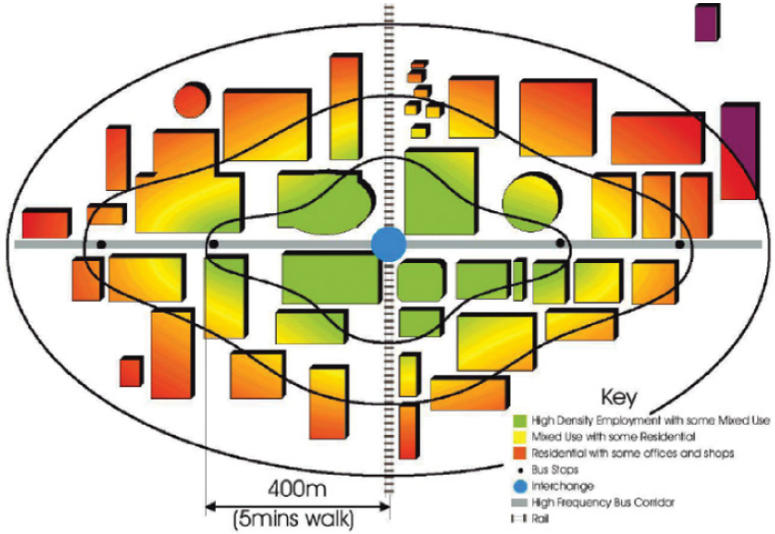

Figure 3.52 An Example of Microdesign and Walking Isochrones
Source: Colin Buchanan and Partners (2001).

TOD

An example of TOD: Railway Station of Zuidas in Amsterdam

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TOD in Vallingby (Sweden)

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Rieselfeld, Freiburg

- 12.000 abitanti
- 15.000 ab/kmq
- 1000 posti di lavoro

- Tram: linea rossa
- Bus: linee blu

Rieselfeld development plan

A central tramline penetrates the Rieselfeld area

3
Haid
VAG
287
V75
1329

presse.com
Zypresse
Alles
226
3 Vauban

Centri commerciali e trasporto pubblico

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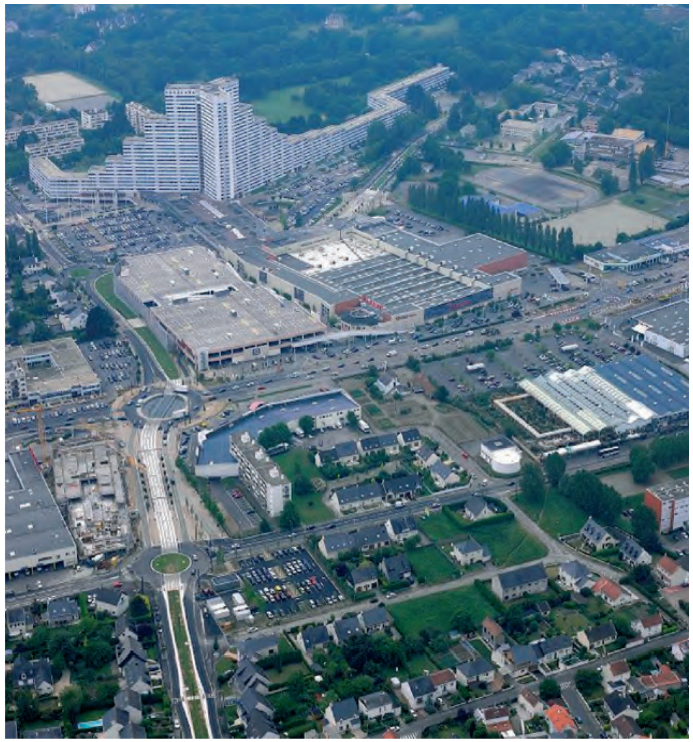

Auchan shopping centre is served by the tram of Nantes

Auchan servito dal tram a Nantes

Parcheggi delle Porte di Catania

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ATTORI E POLITICHE PER EFFICIENZA ENERGETICA NEI TRASPORTI URBANI

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ATTORE	LIVELLO LCALE	LIVELLO NAZIONALE ED EUROPEO
DECISORE	Sindaco e Giunta Municipale Consiglio comunale Dipartimento dei Trasporti Dipartimento di Urbanistica Dipartimento sviluppo economica e finanza	Commissione Europea Governi Ministri dei Trasporti, Ambiente, Energia, Economia, Sviluppo
STAKEHOLDER	Aziende di trasporto pubbliche e private Associazioni di cittadini Professionisti Media	Banche Fondazioni NGO Produttori di veicoli Produttori di carburante Istituzioni di ricerca Media

AZIONI PER EFFICIENZA ENERGETICA NEI TRASPORTI URBANI

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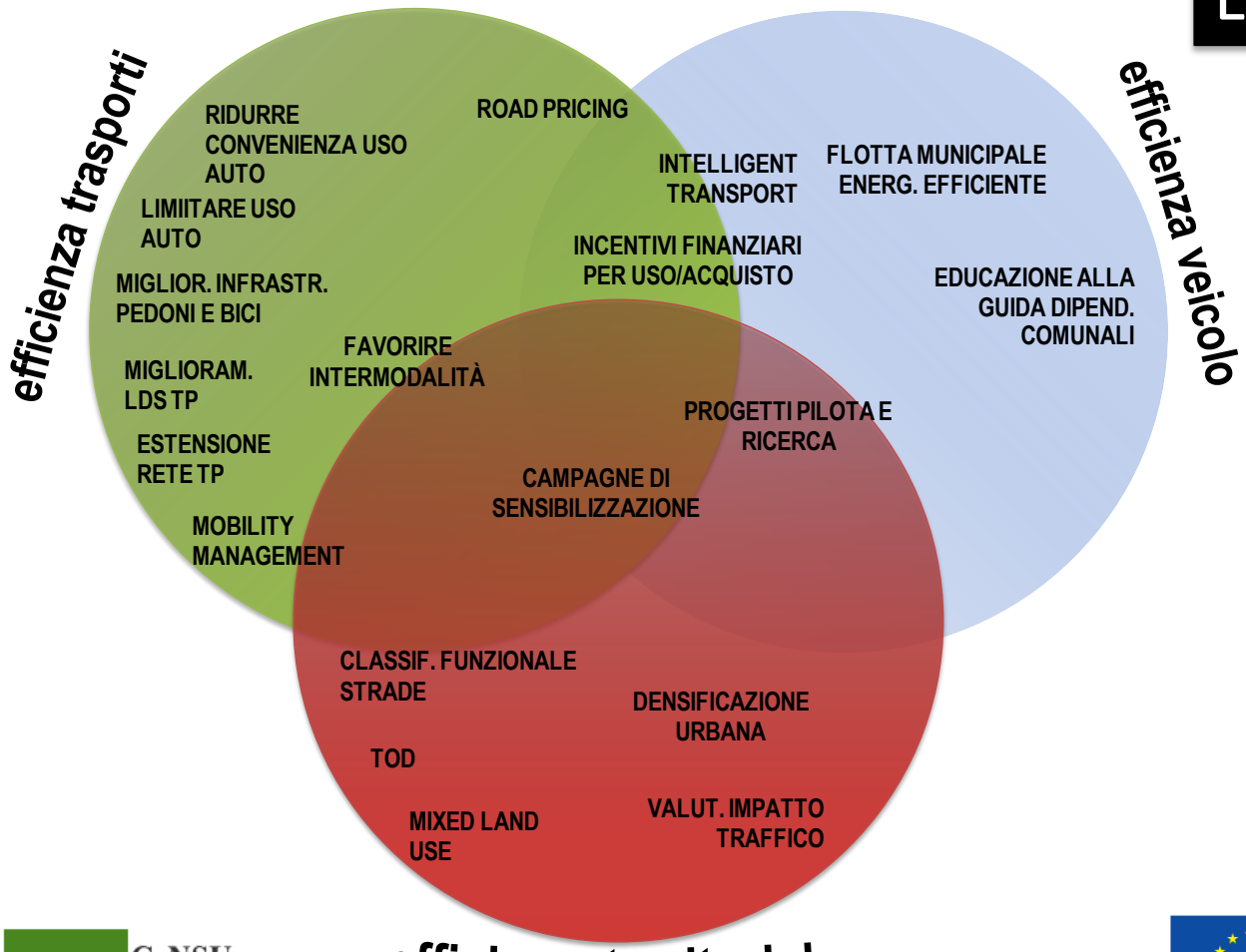
LIVELLO LOCALE



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AZIONI PER EFFICIENZA ENERGETICA NEI TRASPORTI URBANI

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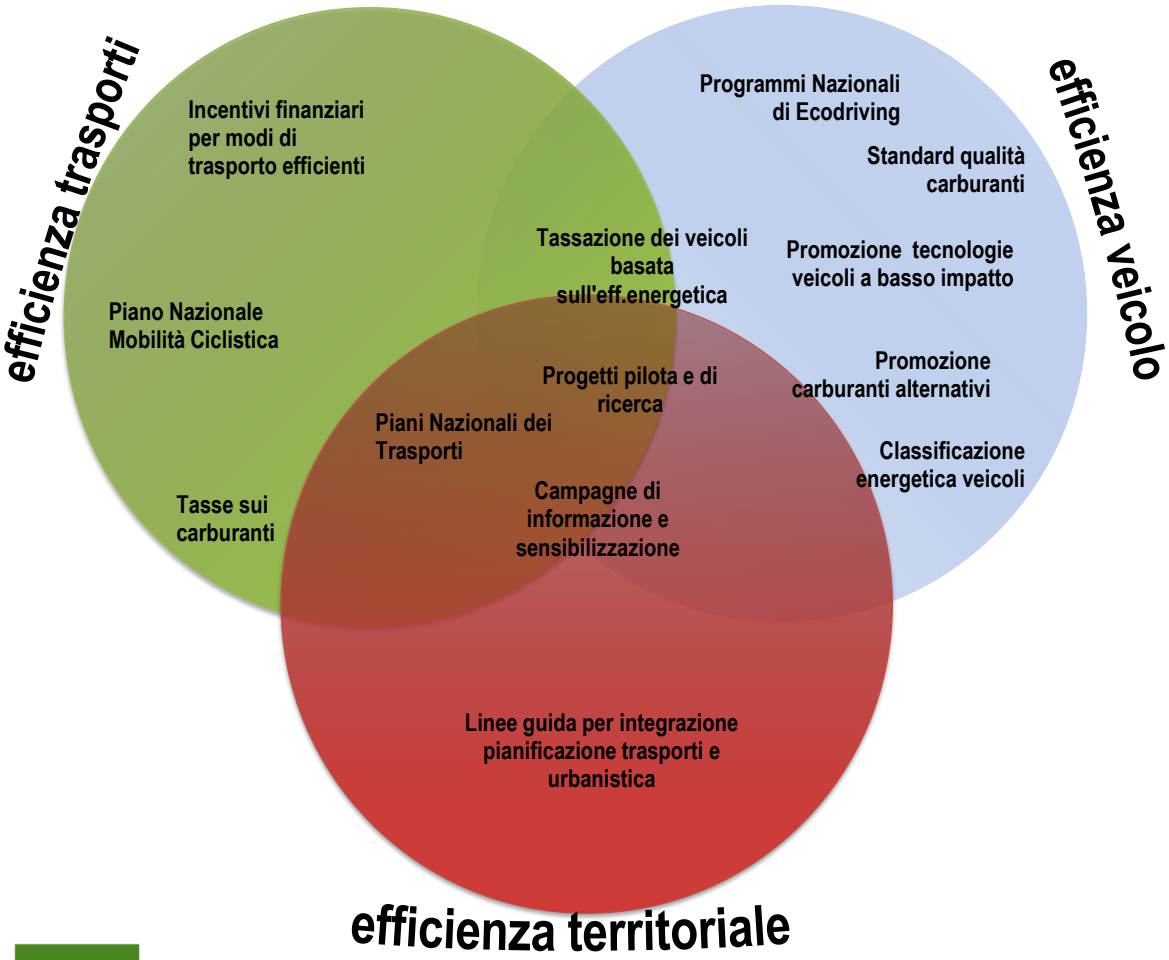
LIVELLO NAZIONALE, EUROPEO



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Densità urbana ed energia trasporti

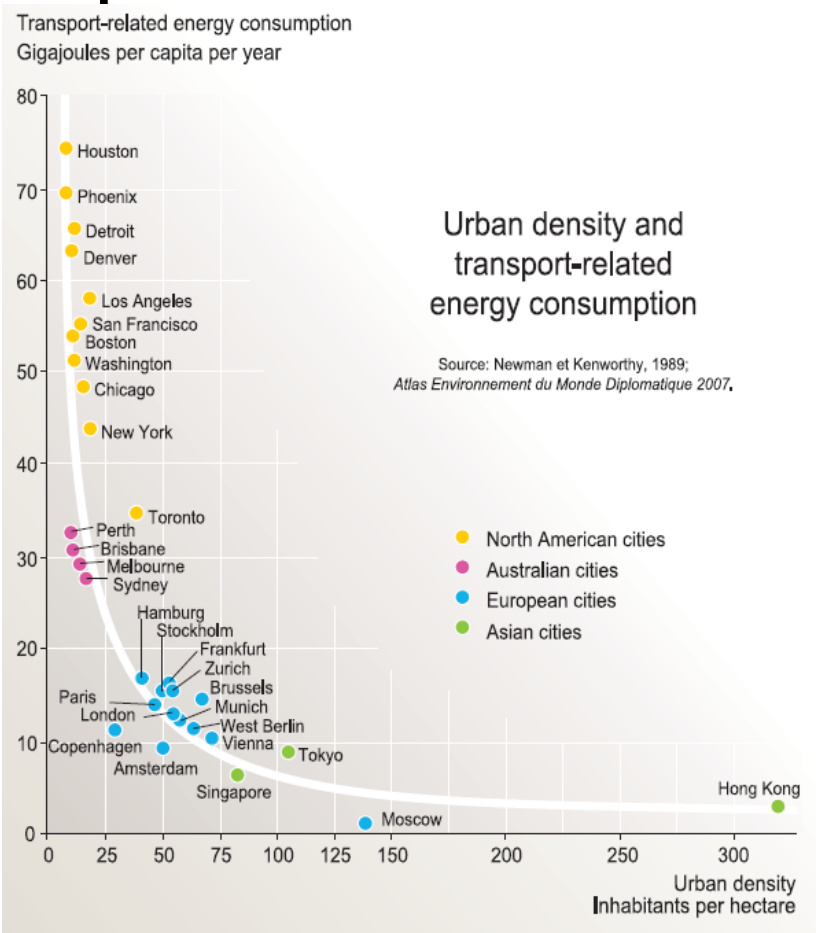

Figure 1 : The Newman and Kenworthy hyperbola: Urban density and transport-related energy consumption

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Densità Media Vs Dinamica Spaziale

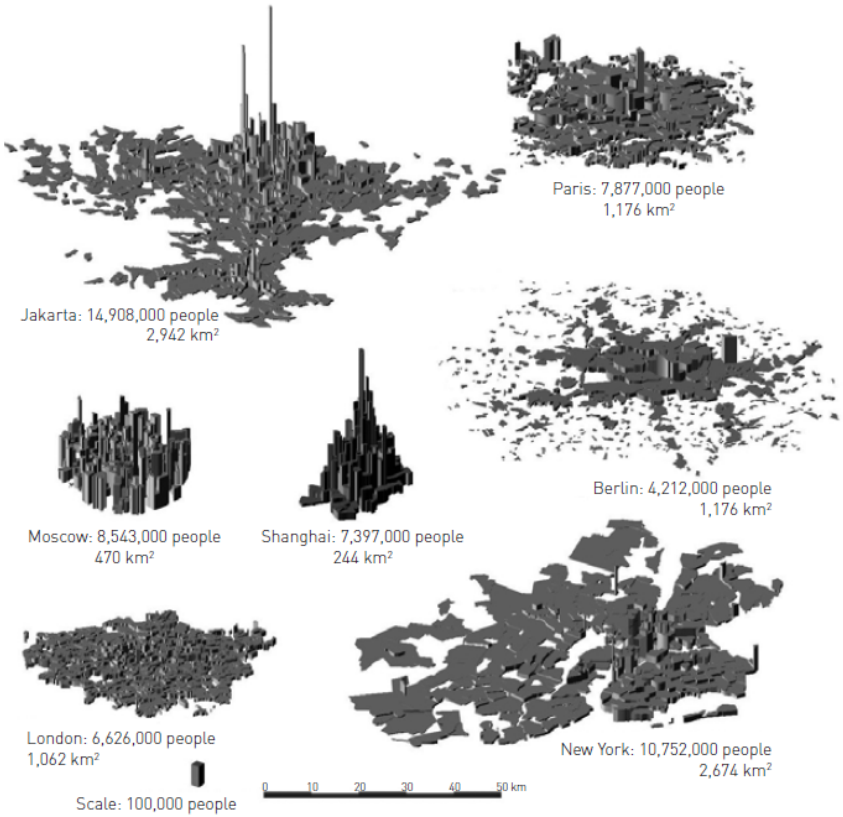

Figure 3. Residential density distribution in several cities. Source: (Bertaud, 2001).

- Un gradiente di densità negativo è generato dalla competizione economica per localizzazioni centrali. È influenzato dalle politiche urbanistiche, tassazione e infrastrutture.
- Un gradiente positivo aumenta il consumo di energia dei trasporti (addensamento origini spostamenti in periferia)

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Distribuzione spaziale degli spostamenti

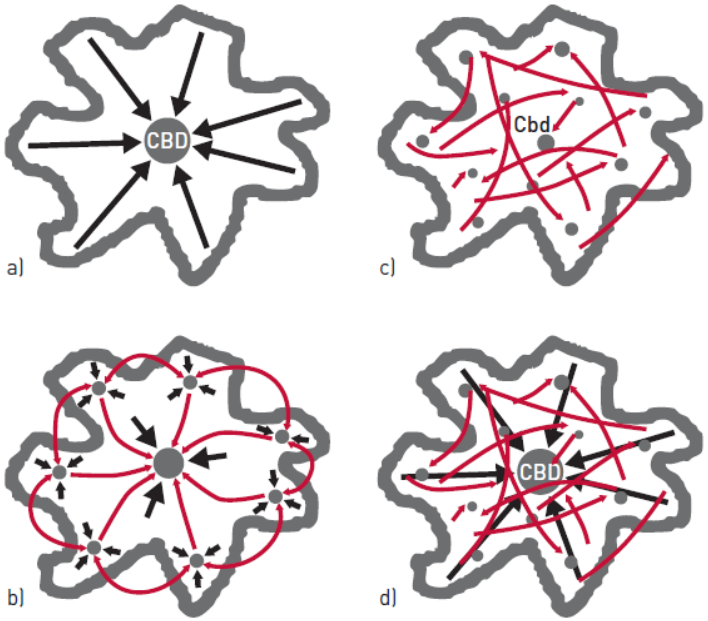

Figure 4. Typologie of urban movement according to Bertaud.

a) The monocentric model

b) The polycentric model: The urban village version

c) The polycentric model: The random movement version

d) The mono-polycentric model: Simultaneous radial and random movements

Legend:Schematic representation of trip patterns within a metropolitan area according to Bertaud. Strong Links (Black arrows) and weak links (Red arrows). Source: (Bertaud, 2001).

a) Londra
b) Stoccolma
c) Los Angeles
d) Evoluzione di una monocentrica in una megalopoli

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Struttura spaziale ed efficacia del trasporti pubblici

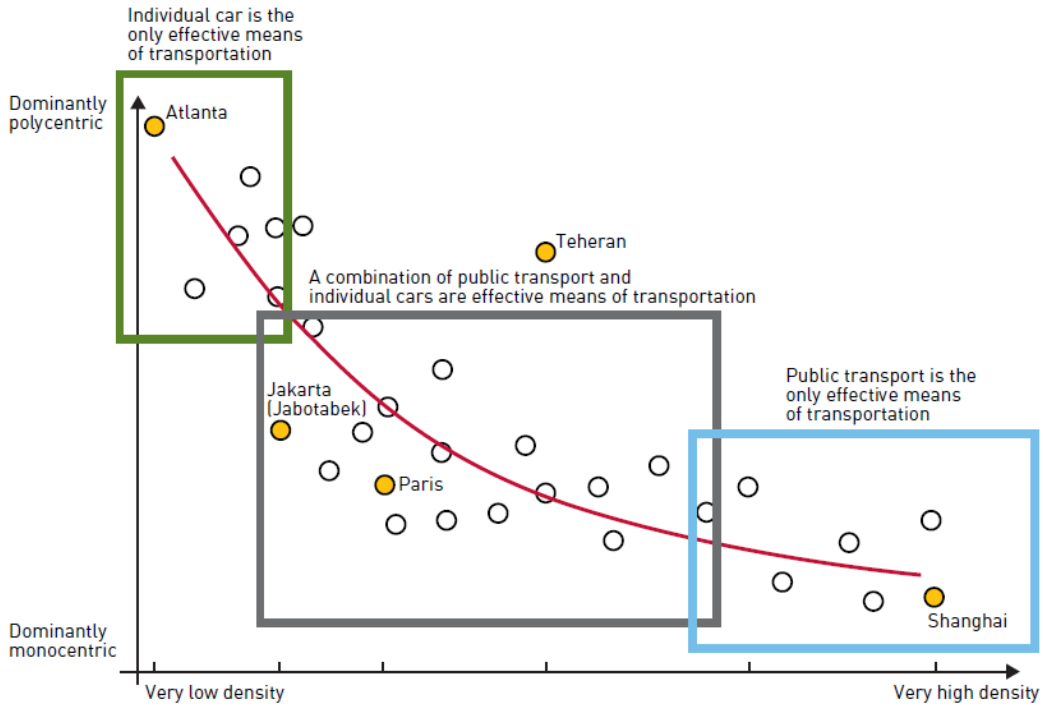

Figure 5. Relationship between Spatial Structure and the Effectiveness of Public Transport. Source: (Bertaud and Malpezzi, 2003).

- Il trasporto pubblico è incompatibile con bassa densità e struttura totalmente policentrica

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Quale modello: Barcellona o Atlanta?

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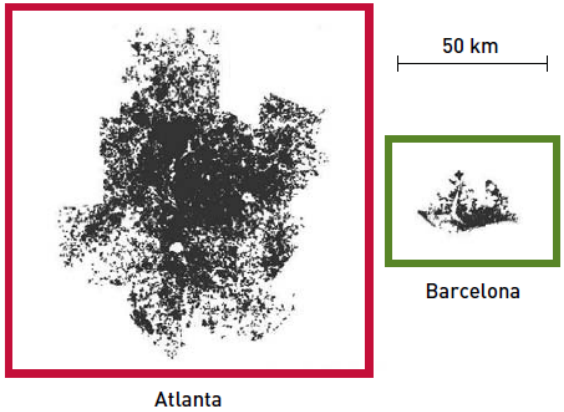

Atlanta	Barcelona
Population: 5.25 million	Population: 5.33 million
Urban area: 4,280 km²	Urban area: 162 km²
7.5 T CO_2/ha /an (public + private transport)	0.7 T CO_2/ha /an (public + private transport)

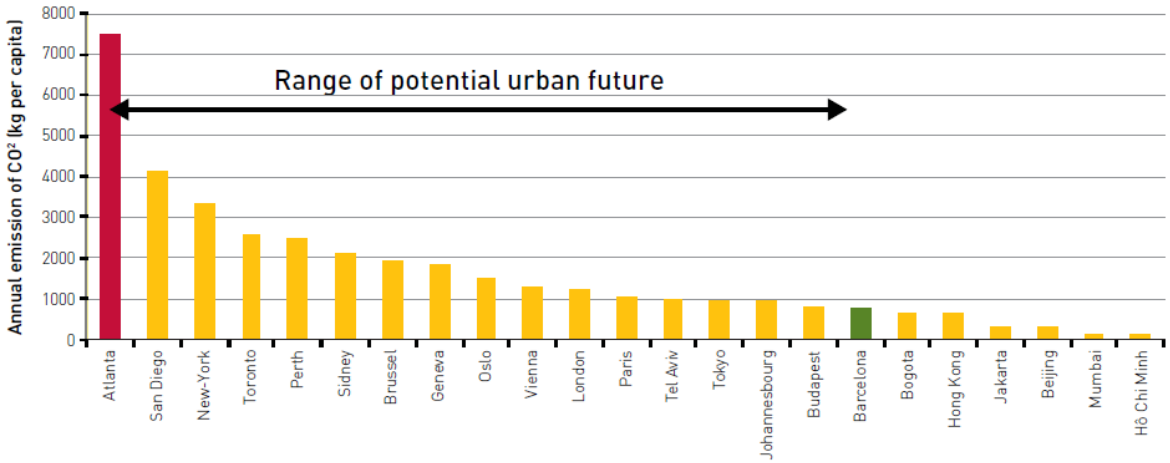

Figure 6. Atlanta or Barcelona, the range of possible urban futures. Source : Adapted from (Newman and Kenworthy, 1999).

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Urban modelling

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- Modelli complessi di interazione trasporti territorio per i ricercatori
- La pianificazione urbanistica e dei trasporti ha bisogno di modelli semplici per indirizzare lo sviluppo lungo i percorsi della sostenibilità

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Modello di calcolo dell'Efficienza Energetica del sistema urbano Territorio-Trasporti

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Modello di calcolo della Dipendenza Energetica dei Trasporti

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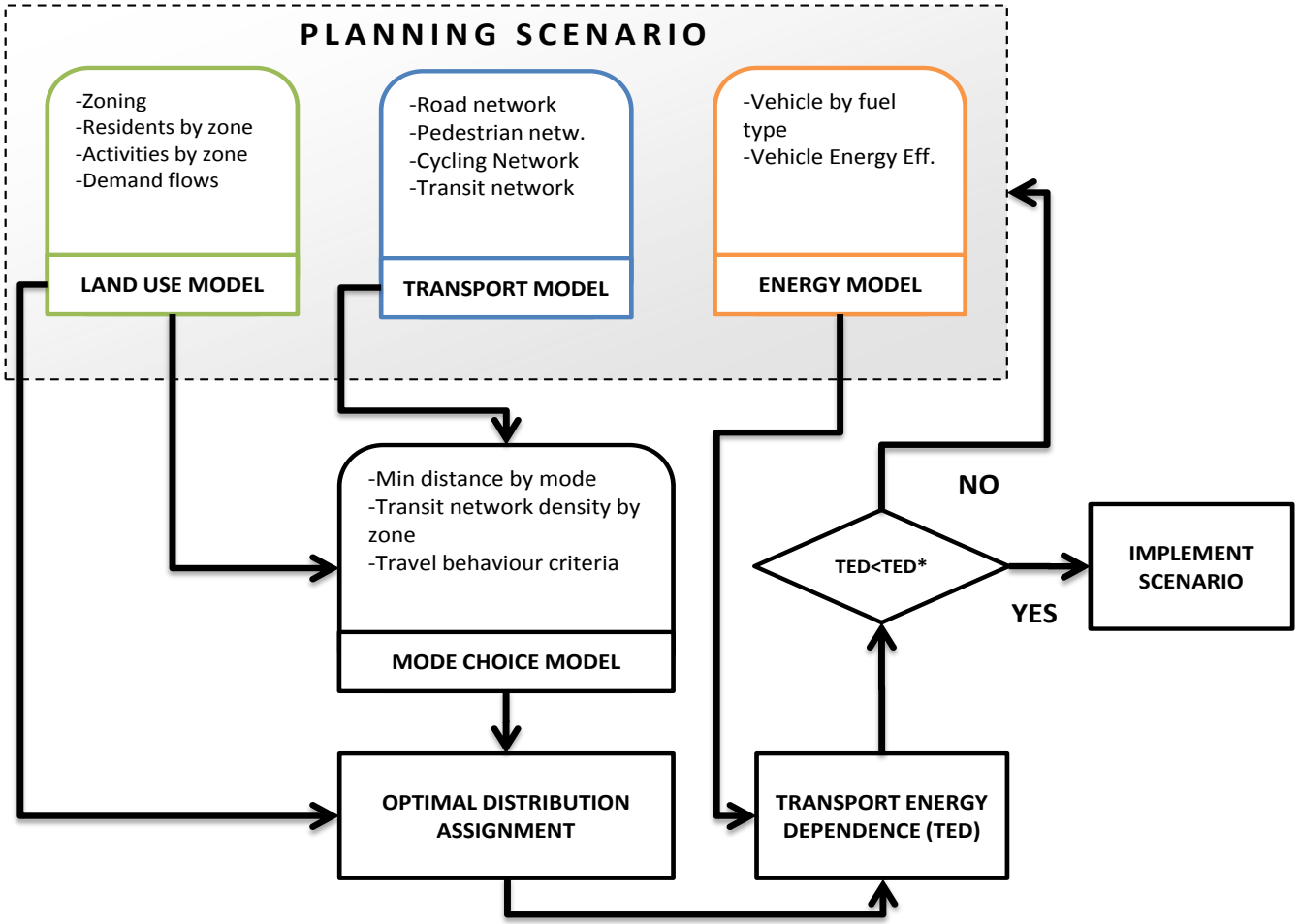

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Caso studio Catania - Scenario di piano

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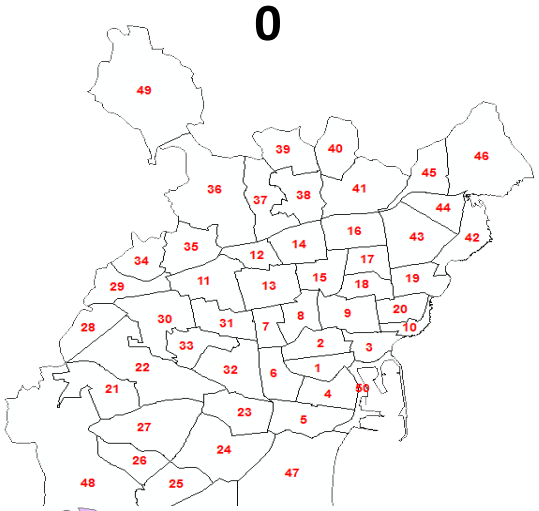

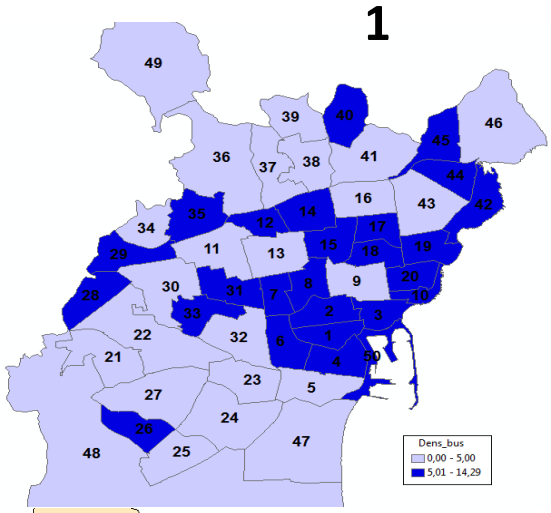

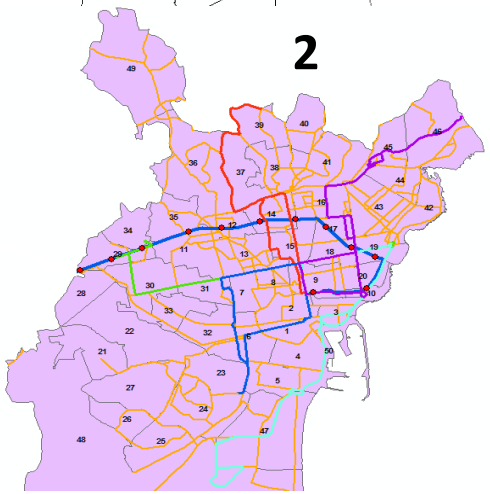

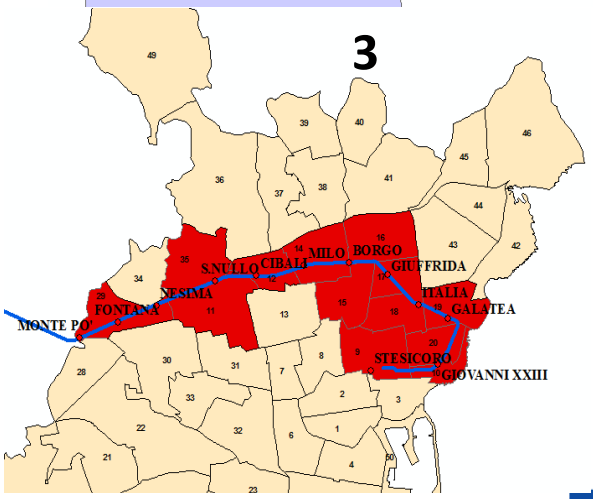

- Sc. 0: situazione attuale
- Sc. 1: accessibilità al TPL
- Sc. 2: Rete BRT e metro
- Sc. 3: politiche TOD

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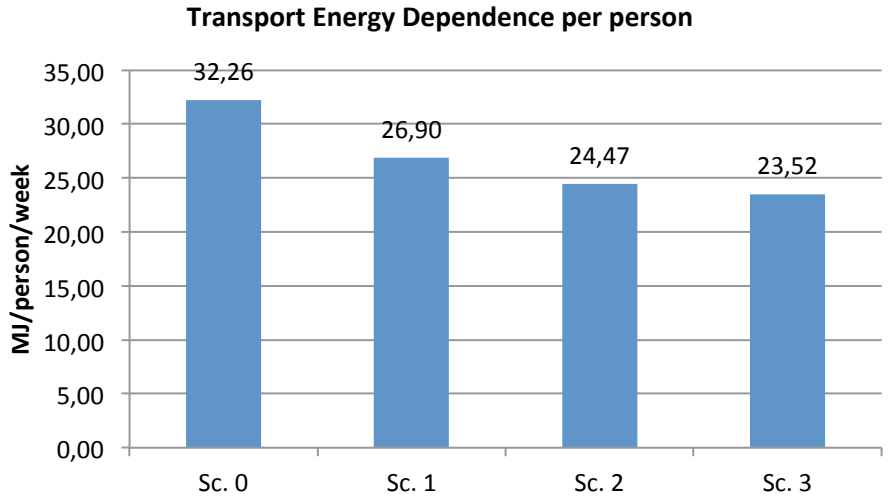
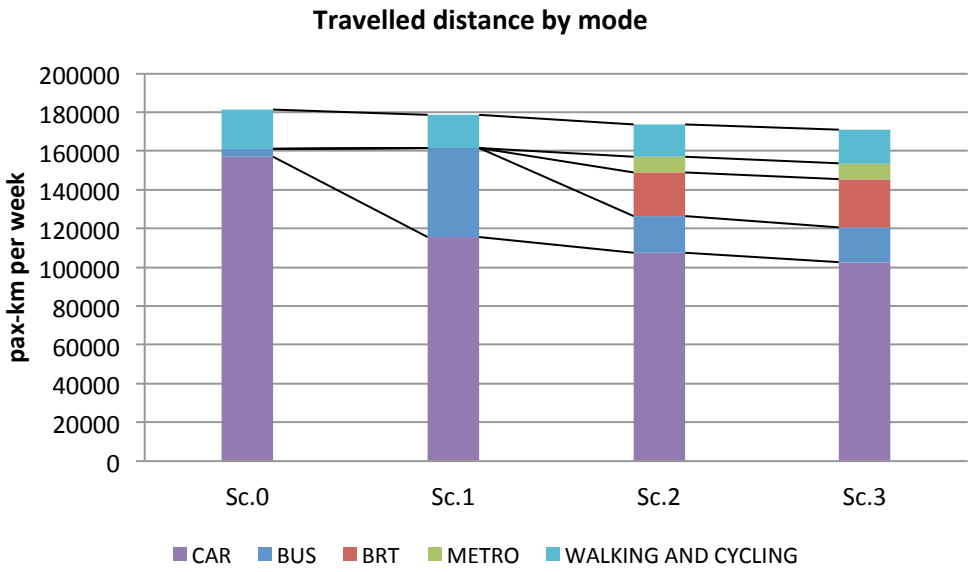
Energia per persona e ripartizione modale





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- Sc. 0: situazione attuale
- Sc. 1: accessibilità al TPL
- Sc. 2: Rete BRT e metro
- Sc. 3: politiche TOD

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Energia per zona e per residente

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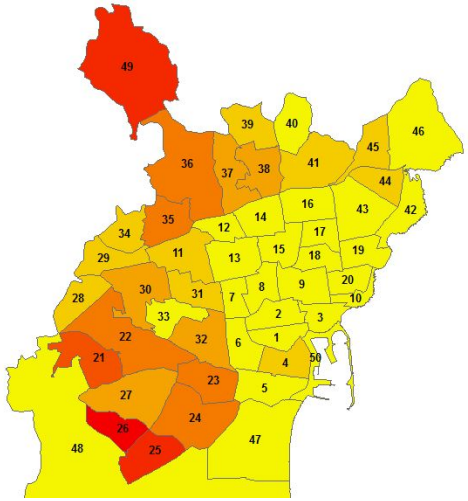

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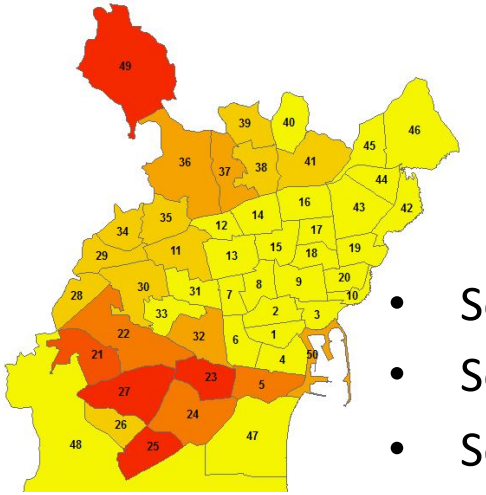
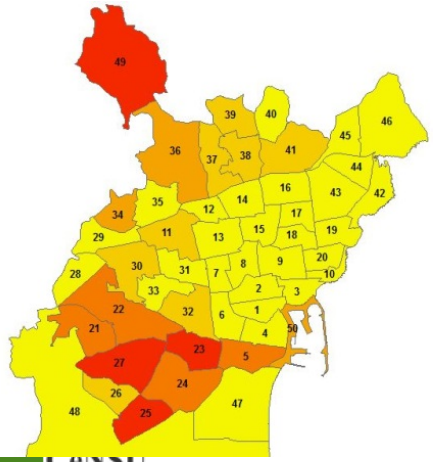


- Sc. 0: situazione attuale
- Sc. 1: accessibilità al TPL
- Sc. 2: Rete BRT e metro
- Sc. 3: politiche TOD

2



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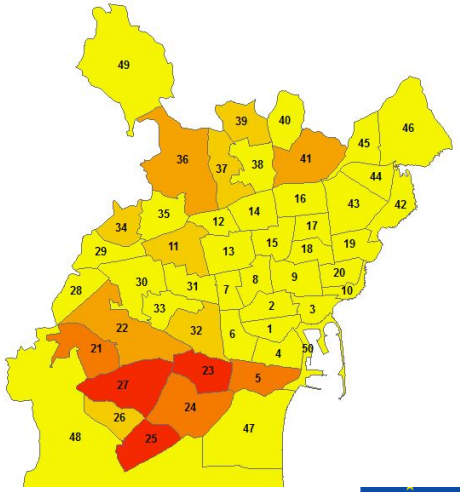

TED
0 - 4
5 - 8
9 - 12
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25 - 26

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CASI STUDIO

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Linea BRT1 di Catania

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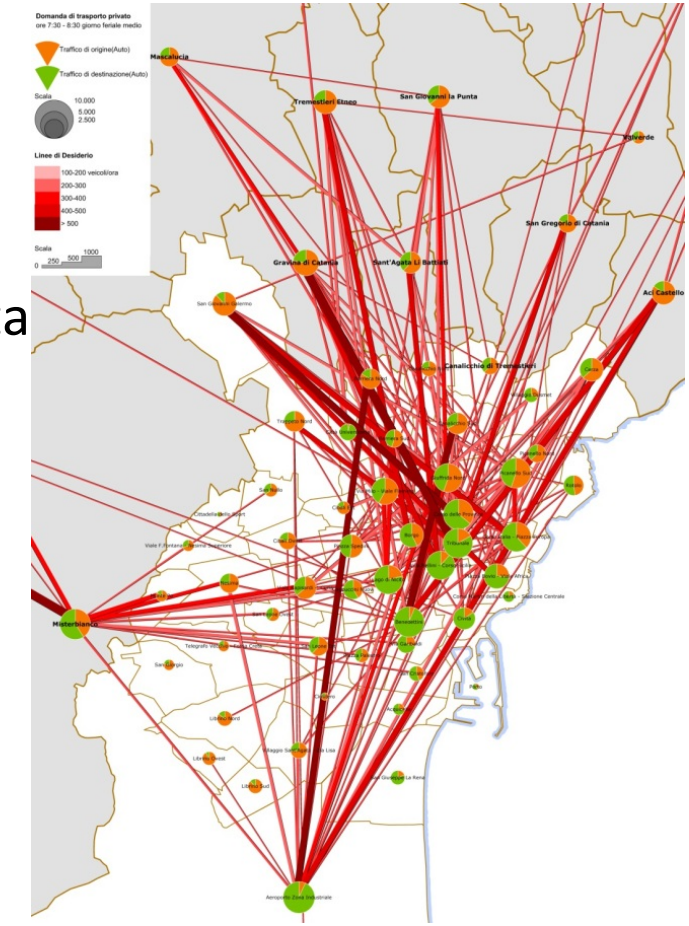
TPL a Catania

- Municipalità 300.000 abitanti
- Città metropolitana 500.000 abitanti
- Area metropolitana 750.000 abitanti
- 700 automobili per 1000 abitanti
- 60.000 auto in penetrazione nell'ora di punta
- TPL
  - copre il 40% della rete stradale
  - Frequenza media 3 bus/h
  - 10 mil km
  - 30 mil pax
  - 13% spostamenti urbani
  - Metro in costruzione
  - Parcheggi scambiatori non utilizzati



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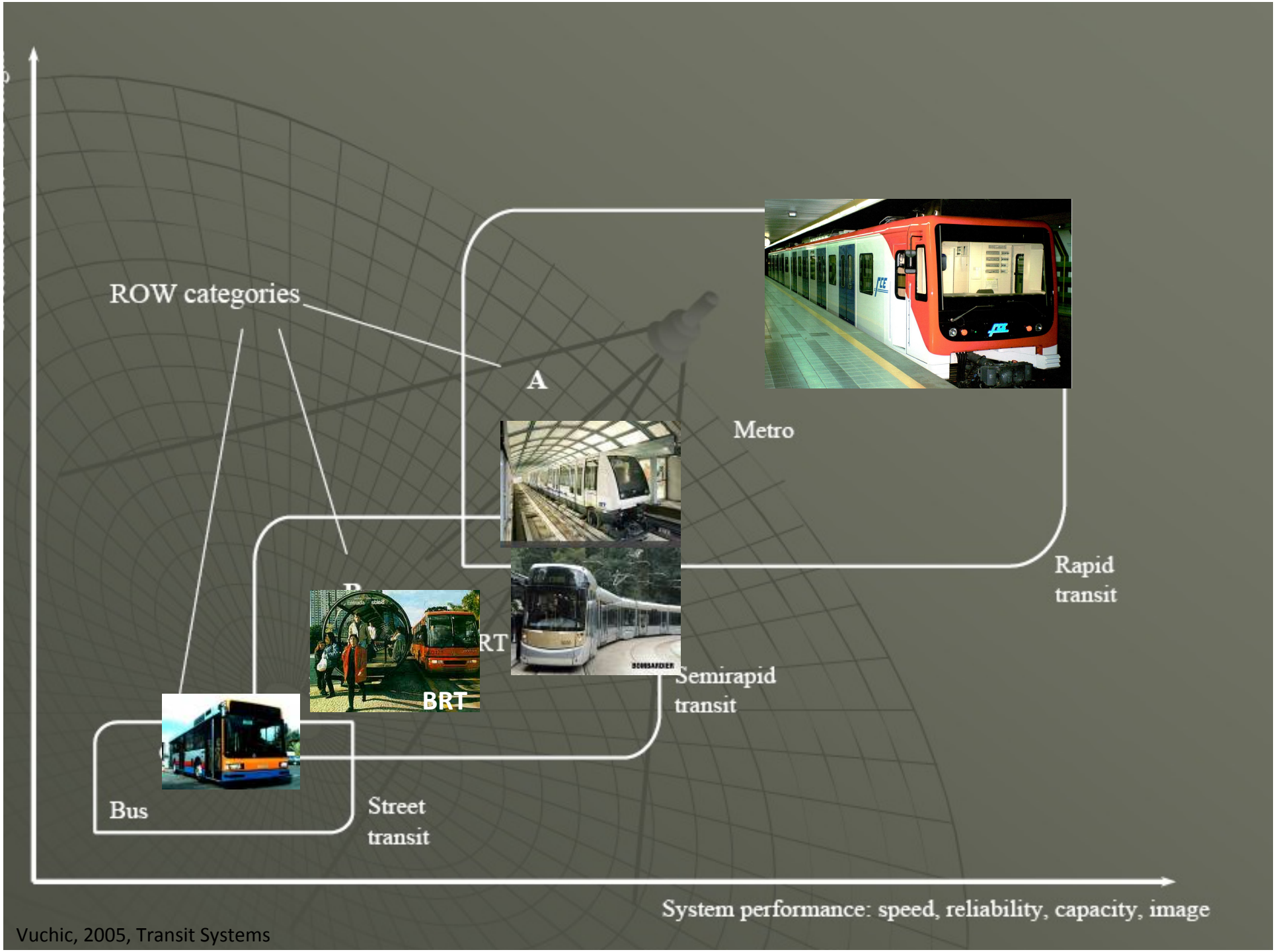

Vuchic, 2005, Transit Systems

Bus Rapid Transit

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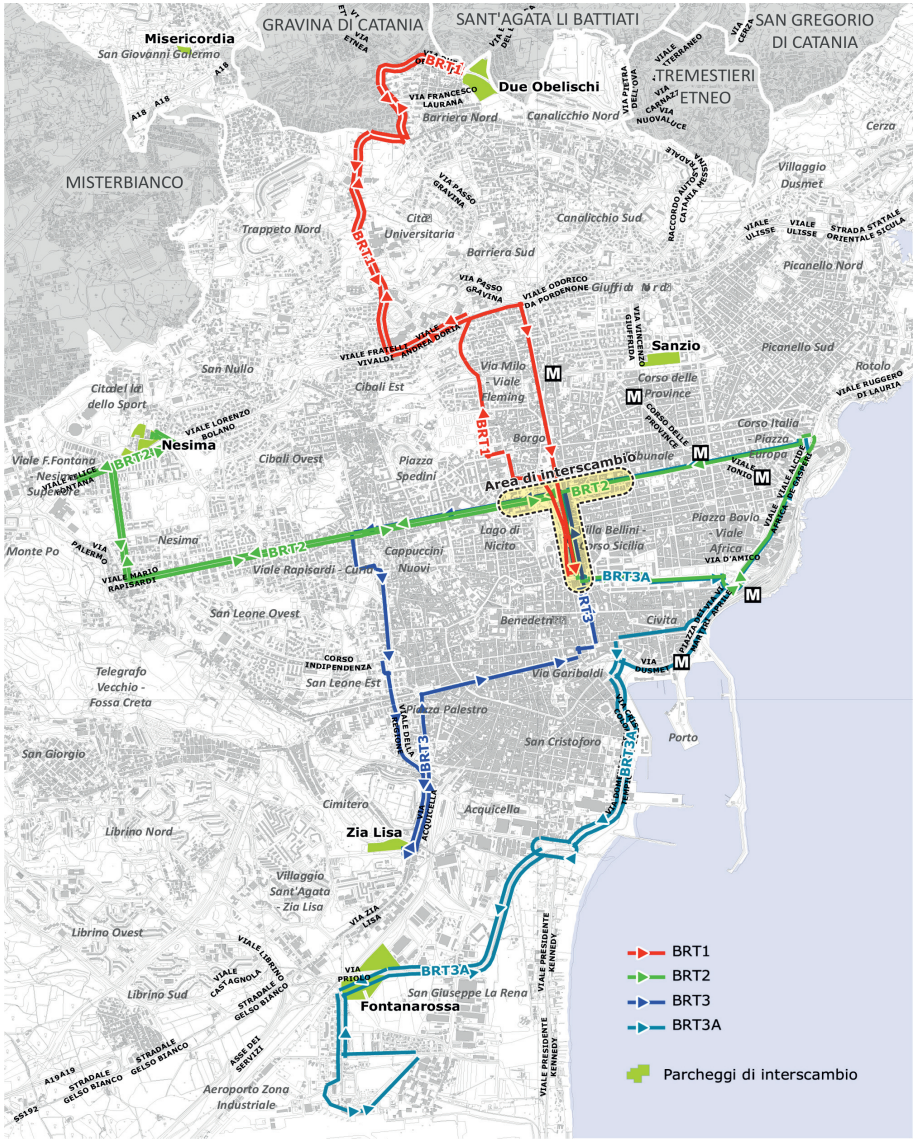
Rete BRT Catania (PGTU, 2013)



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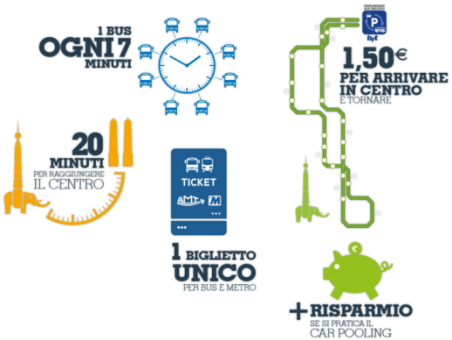
Linea BRT1 Catania

Il Bus Rapido scambia con bus di linea urbana e metropolitana per raggiungere centro storico e commerciale.



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TITOLI DI VIAGGIO ANDATA/RITORNO 1 titolo corrisponde a 2 biglietti da 90 minuti validi esclusivamente nella giornata di emissione (*)		€
P + AMT Sosta gratuita	N°1 + = A	1,50
	N°2 + = A A	2,50
	N°3 + = A A A	3,00
	N°4 + = A A A A	4,00

TITOLI DI VIAGGIO GIORNALIERI Validi esclusivamente nella giornata di emissione (*)		€
P + AMT Sosta gratuita	N°1 + = G	2,50
	N°2 + = G G	4,00
	N°3 + = G G G	6,00
	N°4 + = G G G G	8,00

(*) È comunque necessario obliterare i biglietti in vettura.

Per chi non usufruisce del parcheggio, valgono le tariffe della bigliettazione ordinaria AMT.

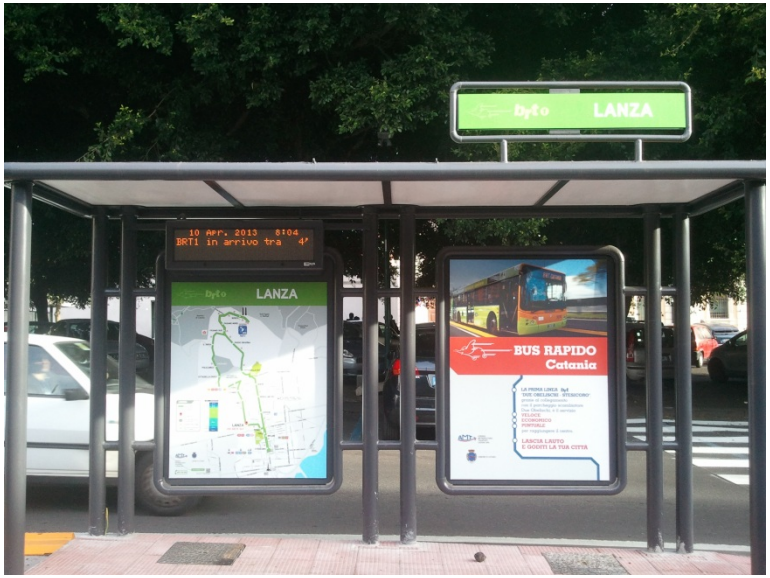
DURATA DELLA SOSTA In mancanza di acquisto di un titolo di viaggio AMT, le tariffe per la sosta sono le seguenti:	€
Fino a 1 ora	0,50
Fino a 2 ore	1,00
Oltre 2 ore e fino alle ore 24.00 del giorno di ingresso	1,50

N.B.: l'eventuale prolungamento della sosta oltre le 24 ore (fino al massimo consentito di 7 giorni consecutivi) verrà tariffato secondo le stesse modalità espresse nella superiore tabella.

IL PARCHEGGIO È FUNZIONANTE DALLE ORE 4.45 ALLE ORE 24.00

ORA	FREQUENZA BUS
5:00 ▶	20 min
6:00 ▶	15 min
6:30 ▶	10 min
7:00 ▶	7 min
14:30 ▶	10 min
21:00 ▶	15 min
22:00 ▶	20 min
24:00 ▶	

Linea BRT1 Catania



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Linea BRT1 Catania

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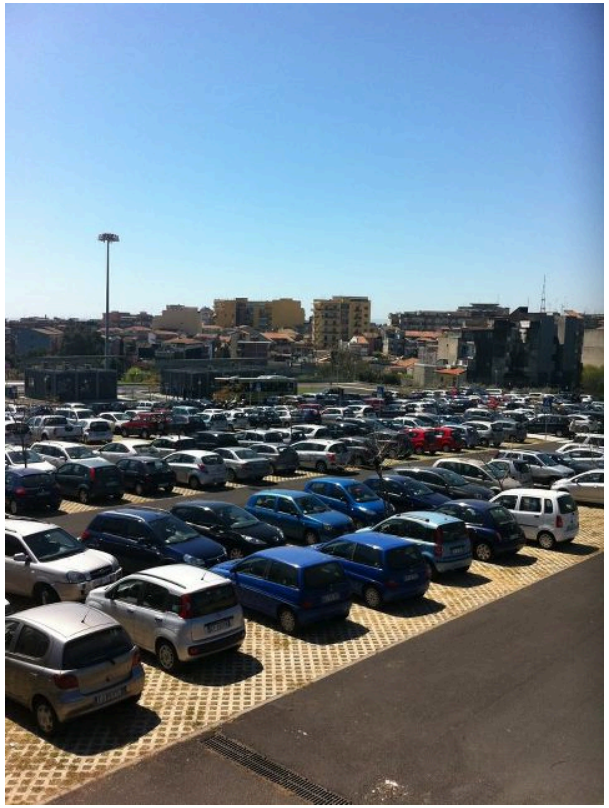

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I numeri del BRT1 di Catania

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- Lunghezza 12.8 km
- Numero fermate 18
- Sede protetta da cordolo 50%
- Priorità semaforica nelle principali intersezioni
- Pensilina con palina intelligente
- Preavviso prossima fermata a bordo
- Livrea vetture ad hoc
- Tariffa park-and-ride a/r da 1 a 1.5 €
- Intertempo mattina 7 min
- Velocità commerciale 21 km/h (50% maggiore della media)
- 5000m pax/giorno
- Occupazione media parcheggio scambiatore 500 auto
- Costo 2 M€
- **Riduzione CO2 800 t/anno**

BRT e TOD

Cities 28 (2011) 527–535

Contents lists available at ScienceDirect

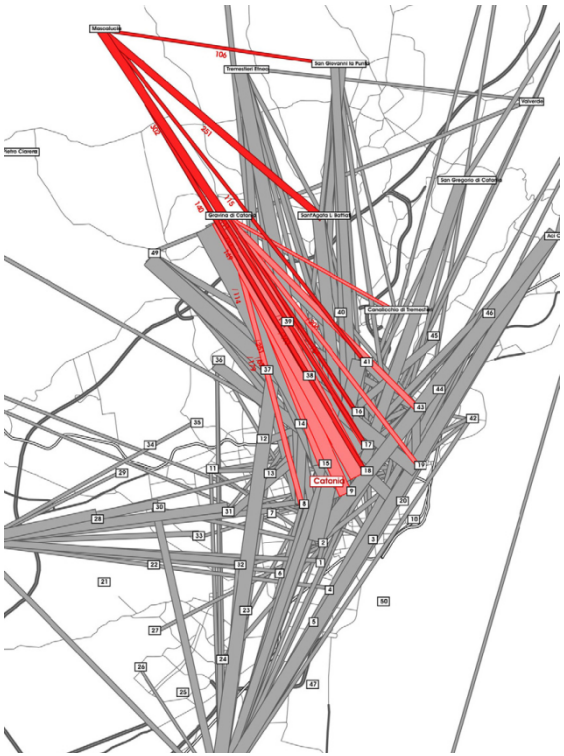
Cities

journal homepage: www.elsevier.com/locate/cities

The density dilemma. A proposal for introducing smart growth principles in a sprawling settlement within Catania Metropolitan Area

Paolo La Greca [a,*], Luca Barbarossa [a], Matteo Ignaccolo [b], Giuseppe Inturri [b], Francesco Martinico [a]

[a] Università di Catania, Dipartimento di Architettura, Italy
[b] Università di Catania, Dipartimento di Ingegneria Civile e Ambientale, Italy



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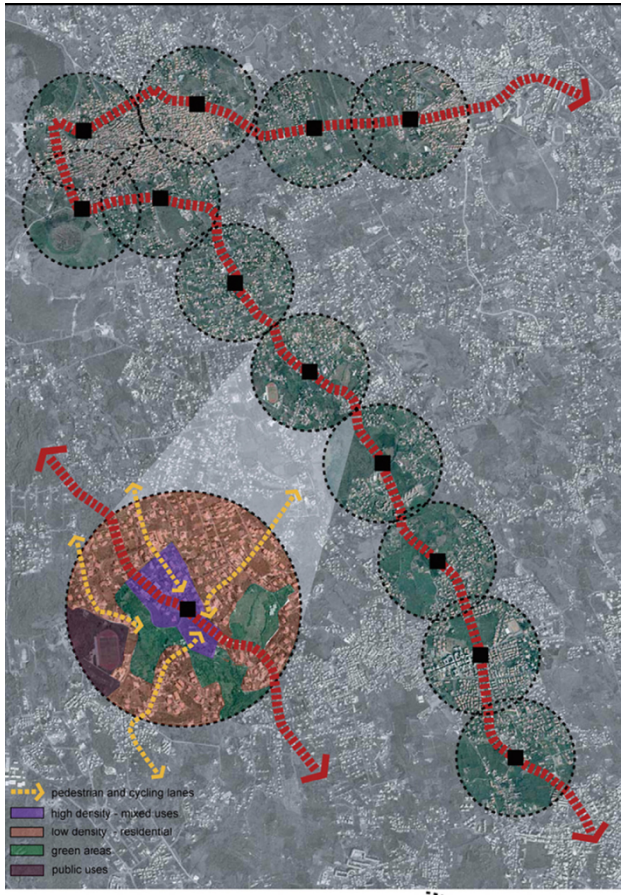

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Il sistema dei crediti di mobilità di Genova

ITS per ridurre il consumo di energia

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MODELLI URBANI TRASPORTI USO DEL TERRITORIO

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Casi studio dal Portfolio di SPECIAL

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1. The first Bus Rapid Transit (BRT) line (Catania, Italy)
2. Sustainbale transports in Malmo
3. Sustainable Urban Mobility Plan (City of Judenburg / Styria, Austria)

Sustainbale transports in Malmo

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- The City of Malmö developed a traffic and mobility plan in terms of a local **Sustainable Urban Mobility Plan (SUMP**).
- In the period 2006 to 2011 the amount of individual **motor car traffic decreased by 6%** (17.700 cars per day) despite of a **population increase of 9 % and an increase of workers of 15 %.**
- The innovative aspect is targeting specific user groups, e.g. by travel behaviour campaigns
- Additionally to "hard" measures of traffic steering and planning and implementation of low carbon traffic strategies also **soft measures** such as information, marketing, education and guidance are necessary for an successful implementation of a Sustainable Urban Mobility Plan (SUMP)

Sustainable Urban Mobility Plan (City of Judenburg / Styria, Austria)

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- The **ADVANCE Audit** is a practical tool for improving Sustainable Urban Mobility Plans (SUMPs) in cities and municipalities.
- It provides a systematic evaluation method to compare the cities' mobility planning to an ideal sustainable urban mobility planning process.
- The main tool of the ADVANCE Audit is the **self-assessment** questionnaire.
- It is filled in by the members of the ADVANCE working group (**cities representatives and internal stakeholders**).
- The output of the Audit is the so called **Action Plan**.
- It gives detailed information about the measures that need to be implemented in order to improve Sustainable Urban Mobility Planning in Judenburg.

Transport development planning Greifswald (Germany)

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- In December 2008 important stakeholders in the area of climate protection of Greifswald formed the climate protection alliance Greifwald 2020)
- The public utilities as main energy producer as well as housing companies, the clinical centre and the city administration as the biggest energy consumer are represented in this alliance.
- Signing the declaration the alliance members target to reduce the CO2 emission in the municipality by 2020 by 14% in comparison to 2005.

Transport in Bahnstadt Heidelberg (Germany)

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- Bahnstadt is one of Germany's largest urban development projects. With the Bahnstadt campus, Heidelberg is reinforcing its position as the centre of science-based business. Internationally mobile scientists, business professionals and managerial staff will discover an attractive combination of working, residing and living on campus.
- The Bahnstadt campus and SkyLabs are situated just under a kilometre from the Neuenheimer Feld area of Heidelberg where the university's science-oriented faculties, clinics and research establishments are located.

Il caso di Friburgo

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- 220 mila abitanti
- tasso di utilizzo del trasporto pubblico tra i più alti d'Europa
- Uso dell'auto fermo ai livelli dei primi anni Settanta
- centro città chiuso al traffico dal 1973
- 90% dei residenti abita in zone a traffico ridotto
- 70% degli spostamenti urbani avviene a piedi, in bicicletta
- 400 km di piste ciclabili e più di 4.600 parcheggi per i ciclisti
- Applicazione ideale del TOD

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Sistema di monitoraggio, previsione e controllo del traffico in tempo reale

ITS per ridurre il consumo di energia

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Cosa fa

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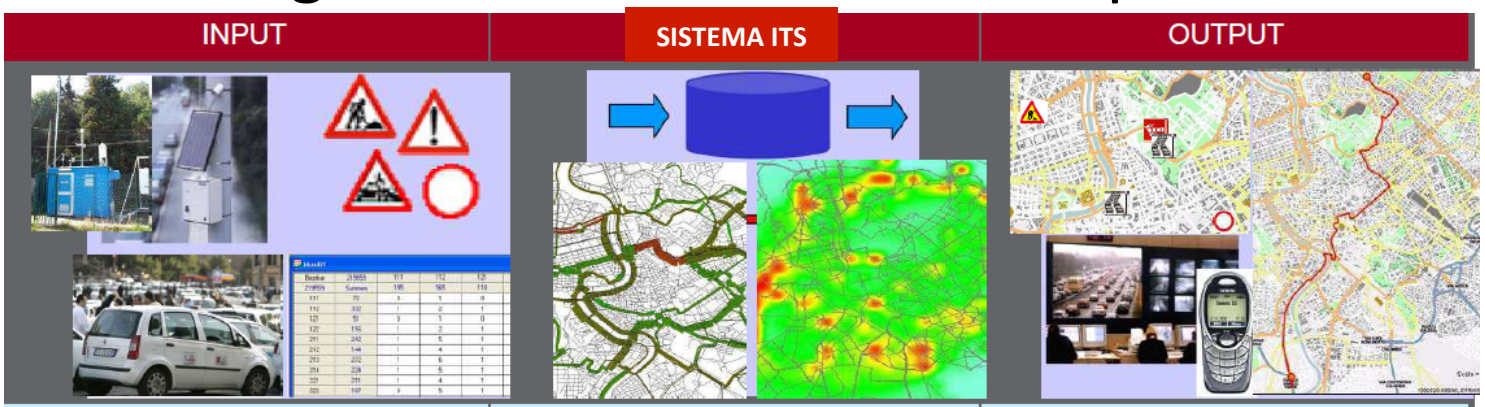
- Monitoraggio traffico da rilevatori fissi e mobili
- **Stima** traffico (flussi e tempi) su tutta la rete urbana
- **Previsione** evoluzione traffico a breve termine (30')
- Informazione ai cittadini affidabile e in tempo reale
- **Controllo** e gestione del traffico in tempo reale



INPUT	SISTEMA ITS	OUTPUT
Veicoli sonda (bus, taxi, ncc, veicoli commerciali) Spire elettromagnetiche Telecamere con OCR Polizia municipale	Modello del sistema di trasporto Simulazione ed Elaborazione Real-Time stima e previsione del traffico calcolo itinerari ottimali	Stato del sistema di trasporto attuale o previsto (traffico, tempi di percorrenza, ...) Strategie di intervento (Decision Support System)

Un esempio

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C'è un incidente…

- **Stima**
  - Sta determinando congestione?
  - Influenzerà il mio tempo di viaggio?
- **Previsione**
  - Quanto sarà lunga la coda tra 15'?
  - Quanto tempo ci vuole per il ripristino delle condizioni di traffico normale?
  - Quanti veicoli saranno bloccati?
  - Quando arriverò in ufficio?
- **Controllo** (Decisione)
  - Conviene chiudere completamente la strada per accelerare la rimozione dei veicoli o è meglio lasciare una corsia aperta
  - Mi conviene cambiare percorso o è meglio fermarmi e prendere un caffè

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Sistema dinamico di infomobilità multimodale

ITS per ridurre il consumo di energia

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Journey Planner

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- Sarà disponibile per i cittadini una piattaforma web in grado di fornire una strategia completa di viaggio per raggiungere la destinazione finale (su dispositivi mobili)
- Fornisce indicazioni sull'uso del trasporto pubblico sensibili alla posizione effettiva dei veicoli delle diverse linee (tempi previsti alle fermate, cancellazione corse, etc..)
- L'utente può personalizzare la richiesta rispetto alle proprie preferenze (pochi tratti a piedi, pochi trasbordi, distanza minima, tempo minimo, costo minimo, etc.)

Norme europee

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- Regulation on CO2 from cars Regulation (EC) No 443/2009
- Regulation EURO 5 and 6 Regulation (EC) No 715/2007
- Fuel Quality Directive Directive 2009/30/EC
- Regulation Euro VI for heavy duty vehicles Regulation (EC) No 595/2009
- Regulation on CO2 from vans Regulation (EU) No 510/2011
- Eurovignette Directive on road infrastructure charging Directive 2011/76/EU
- Directive on the Promotion of Clean and Energy Efficient
- Road Transport Vehicles (in public procurement)
- Directive 2009/33/EC
- End of Life Vehicles Directive Directive 2000/53/EC

Modi di trasporto e distanze urbane

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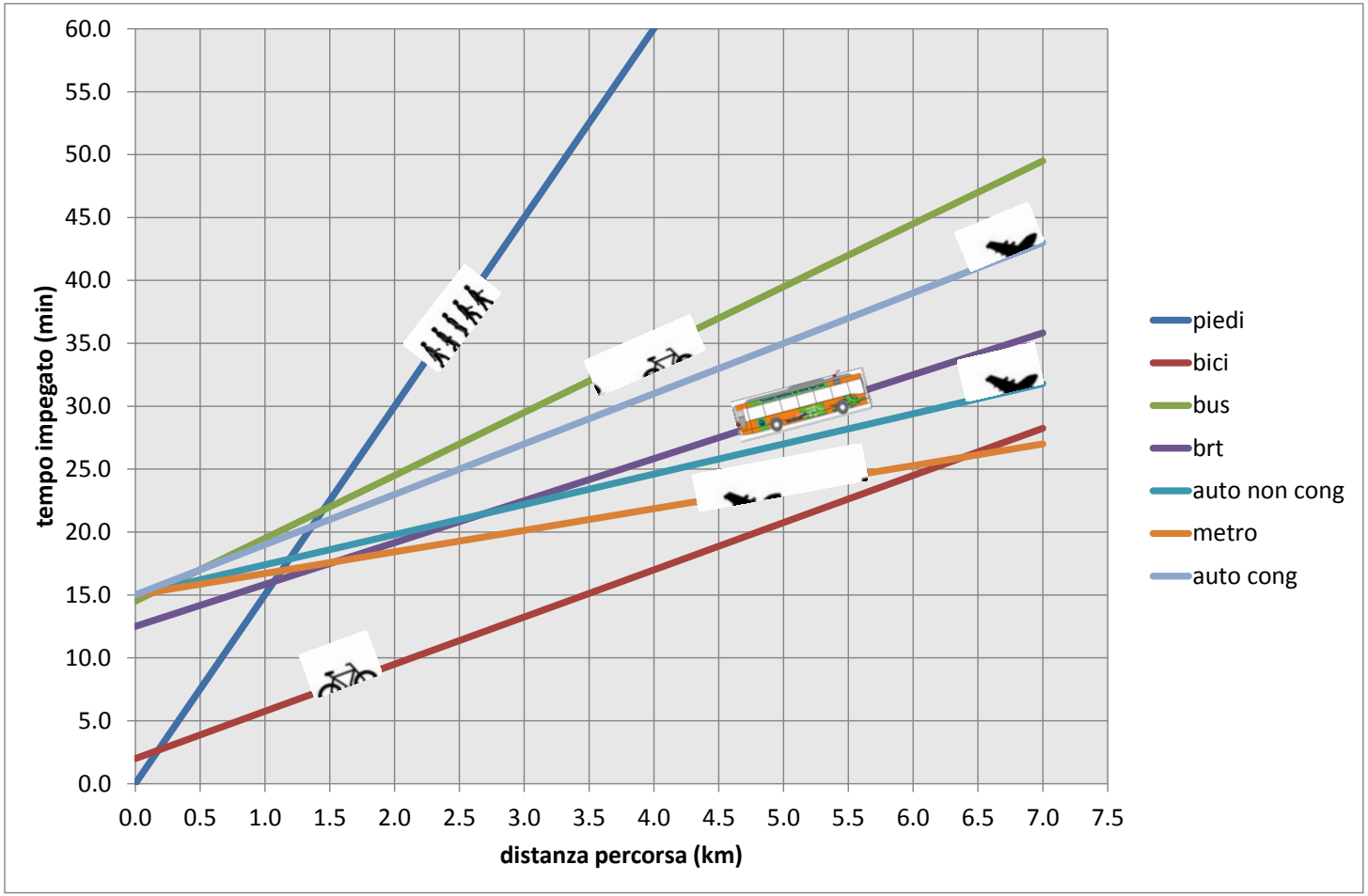

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dal pozzo alle ruote

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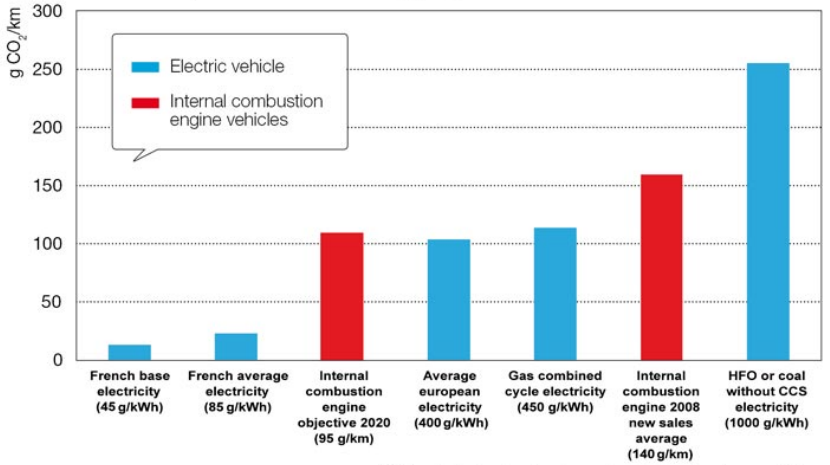
- WTW Well-To-Wheel (MJ/km)
- WTT Well-To-Tank
  - Rapporto tra energia necessaria per rendere disponibile un carburante dalla fonte energetica primaria fino al serbatoio del veicolo e l'energia contenuta nel carburante (MJ_t/MJ_f)
- TWW Tank-To-Wheel
  - Energia necessaria per spostare il veicolo di 1 km (MJ/km)

$$WTW\left[\frac{MJ_t}{km}\right] = WTT\left[\frac{MJ_t}{MJ_f}\right]\cdot TTW\left[\frac{MJ_f}{km}\right]$$

WELL-TO-WHEEL CO_2 EMISSIONS OF ELECTRIC AND INTERNAL COMBUSTION ENGINE VEHICLES

Source: ADEME report on electric mobility, July 2009



* Ademe is the French national agency for environment and energy efficiency

The chart illustrates the large variation of well-to-wheel CO_2 emissions for electric vehicles depending on primary energy uses. For comparison, well-to-wheel CO_2 emissions of internal combustion engine vehicles have been included.

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Livelli di pianificazione dell'energia

- Europeo
- Nazionale
- Regionale
- Municipale

Potenziamento delle capacità mediante la formazione

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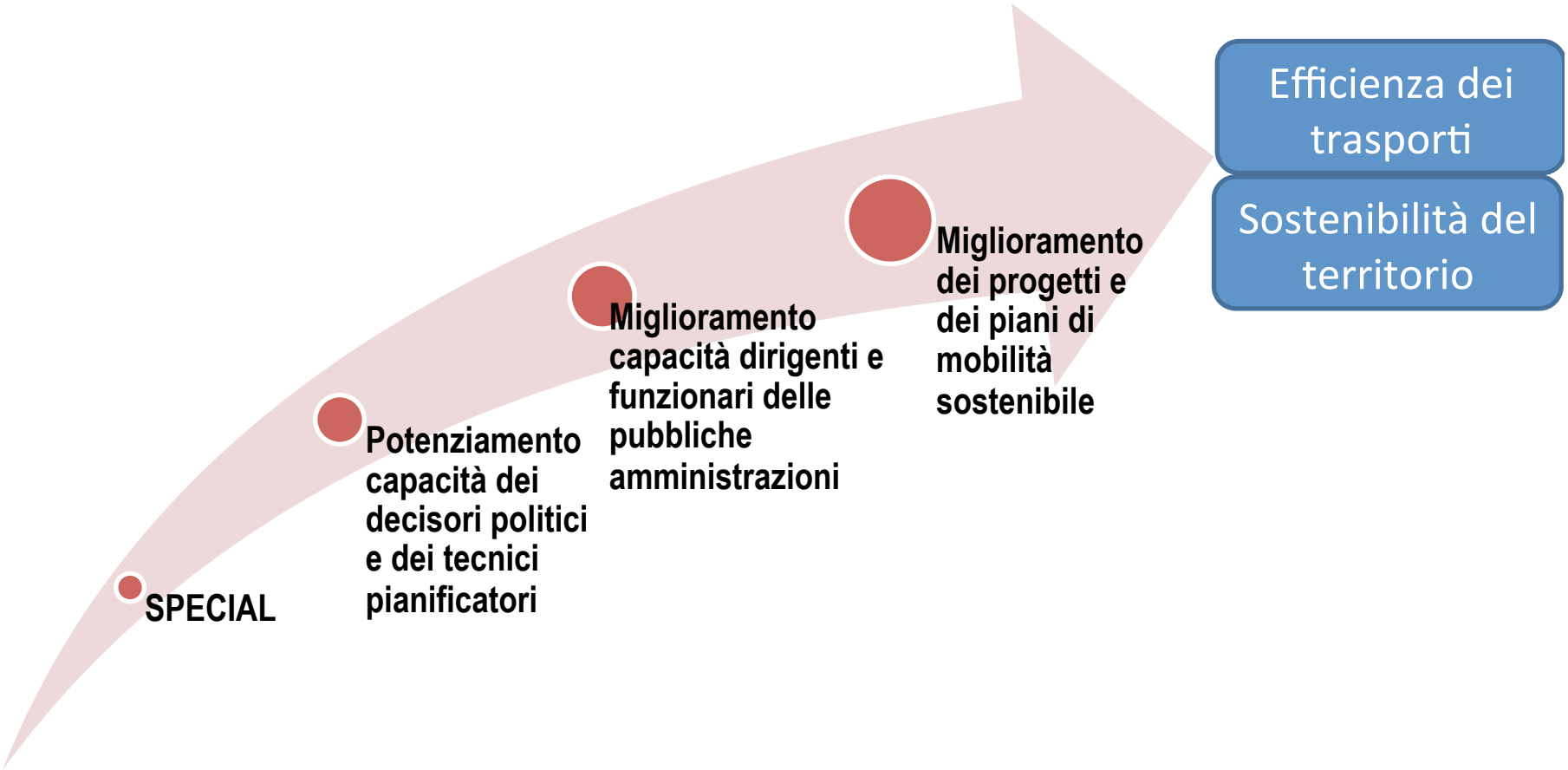

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Esigenze di formazione

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- Capacità istituzionale dei Comuni
  - Agenzia Municipale dell'Energia (città grandi e medie)
    - Audit energetici nei siti comunali
    - Campagne sensibilizzazione
    - Reperimento fondi
    - Attuazione progetti di efficientamento energetico
  - Ufficio Energy Management
    - Monitoraggio consumi e produzione di energia
  - ESCO Energy Service Company

Esigenze di formazione

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- Capacità di pianificatori, esperti ed accademici
  - Dirigenti e funzionari dipartimenti di
    - Pianificazione territoriale
    - Mobilità e trasporti
    - Ambiente ed Energia
    - Etc.
  - Liberi professionisti, consulenti
  - Integrazione corsi di studio e curricula con esperienze e best practice

Modalità di formazione

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- Lezioni frontali
- Lezioni a distanza
- Corsi on line
- CD, DVD
- Video

Calcolo emissione di CO2

$$Em(CO2) = T \cdot CU_{En} \cdot F_{em} = [(S \cdot D) \cdot (CU_{cb} / f_c \cdot F_{conv}) \cdot F_{em}]$$

S	numero di spostamenti	pax
D	distanza media percorsa	km
CUen	consumo unitario di energia	kWh/pax-km
Fem	fattore di emissione	t(CO2)/kWh
CUcb	consumo unitario di combustibile	lt/veic-km
fc	fattore di carico del veicolo	pax/veic
Fconv	fattore di conversione	kWh/lt

Emissione CO2	=	(Traffico)x(Consumo_Unitario_Energia) x (Fattore di emissione)
t_CO2	=	(pak-km) x (kWh/pak-km) x (t_CO2/kWh)
Traffico	=	(spostamenti) x (distanza media)
pax-km	=	(pax) x (km)
Consumo unitario	=	[(consumo unitario combustibile) / (fattore di carico veicolo)] x (fattore di conversione)
kWh/pax-km	=	[(lt/veic-km) / (pax/veic)] x (kWh/lt)

Esempio			
spostamenti	s	500000	pax
distanza media	d	10.0	km
traffico		5000000	pax-km
veicolo		autovettura	
combustibile		gasolio	
consumo unitario combustibile	cuc	0.069	lt/veic-km
fattore di carico veicolo	f_car	1.2	pax/veic
fattore di conversione	f_conv	10	kWh/lt
consumo unitario energia	cue	0.575	kWh/pax-km
fattore di emissione	f_em	0.000267	t_CO2/kWh
Emissione CO2	em	767.625	t

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- Stime Riduzione energia secondo litman
- Software tesi di panebianco

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- Casi studio da GTZ

THIS ONE
RUNS ON FAT
AND SAVES YOU MONEY
THIS ONE
RUNS ON MONEY
AND MAKES YOU FAT

BOX 3.15

Emission-Based Road Pricing in Milan, Italy

In January 2008, Milan introduced EcoPass, a program designed to restrict access to the city center during certain hours of the day by charging fees to drivers of the most heavily polluting vehicles. This is the first urban environmental policy in the region whereby the transportation sector has applied the European Union's polluter pays principle. Significant results have already been achieved through this innovative scheme:

- Traffic has been reduced 19 percent during the enforcement period and 8 percent overall.
- The road speed of public transportation has risen by 11 percent, and public transportation ridership has increased by 10 percent.
- CO_2 emissions have fallen by 12 percent, and the incidence of particulate matter by 19 percent.

Source: Comune di Milano (2009).

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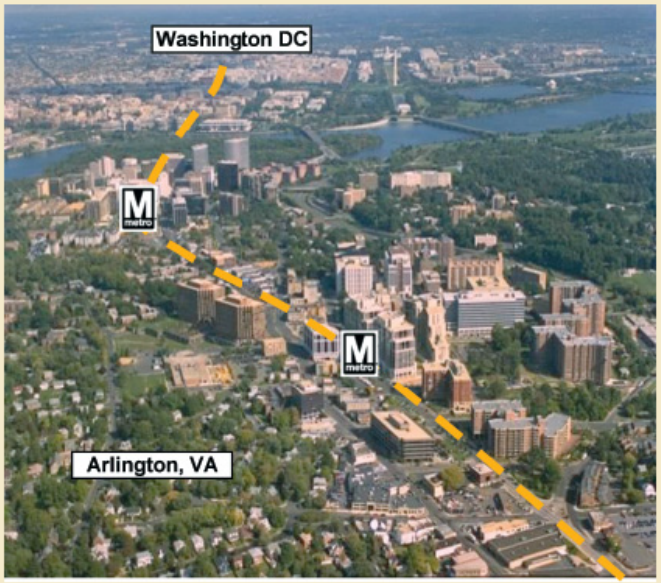

Source: Zimmerman (2008).
Note: The photo on the left shows a high-quality public transportation corridor between Arlington, Virginia, and Washington, D.C., with an underground metropolitan train (the orange line and M) and a feeder bus system. The corridor exhibits many elements of good macrolevel planning and transit-oriented development, including higher densities around high-quality public transportation (the underground) in an otherwise car-oriented environment. After 20 years of mixed use development around stations (such as Clarendon, pictured on the right), the corridor has become a good example of urban form.

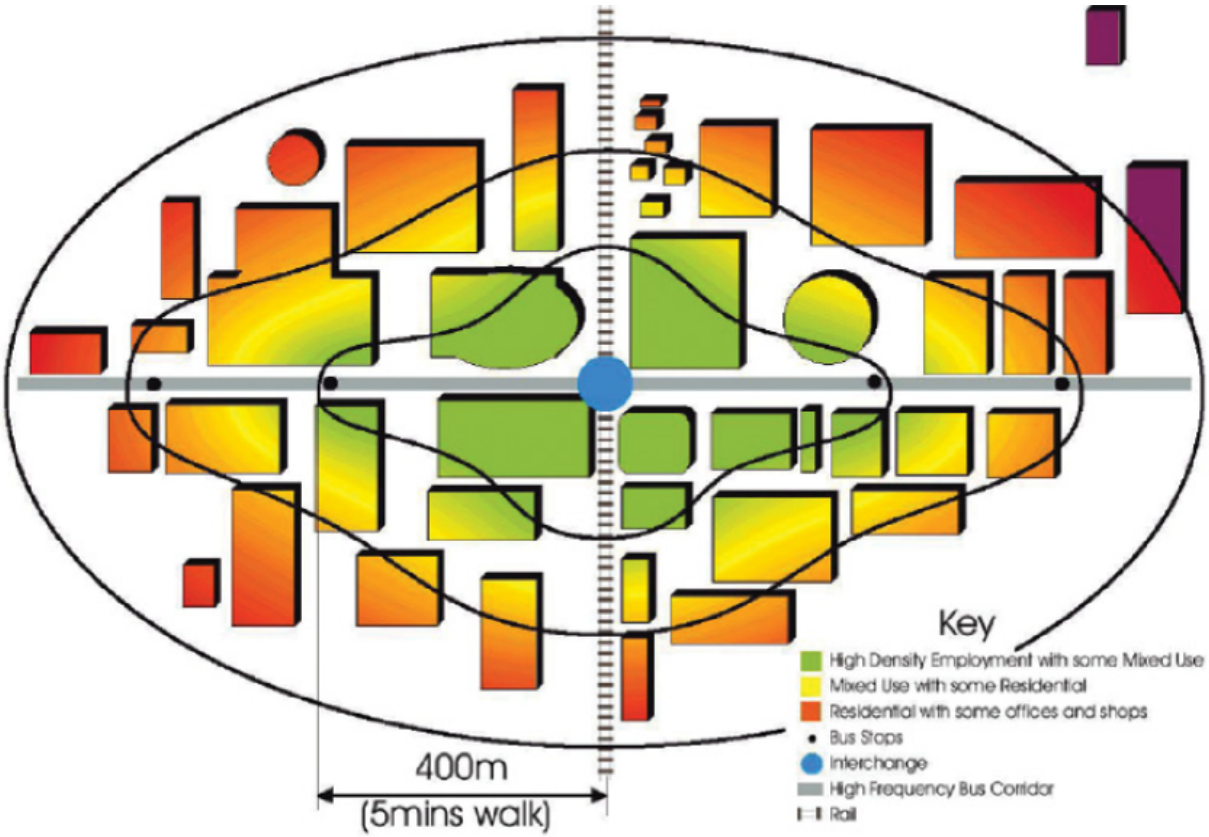

Figure 3.52 An Example of Microdesign and Walking Isochrones

Source: Colin Buchanan and Partners (2001).

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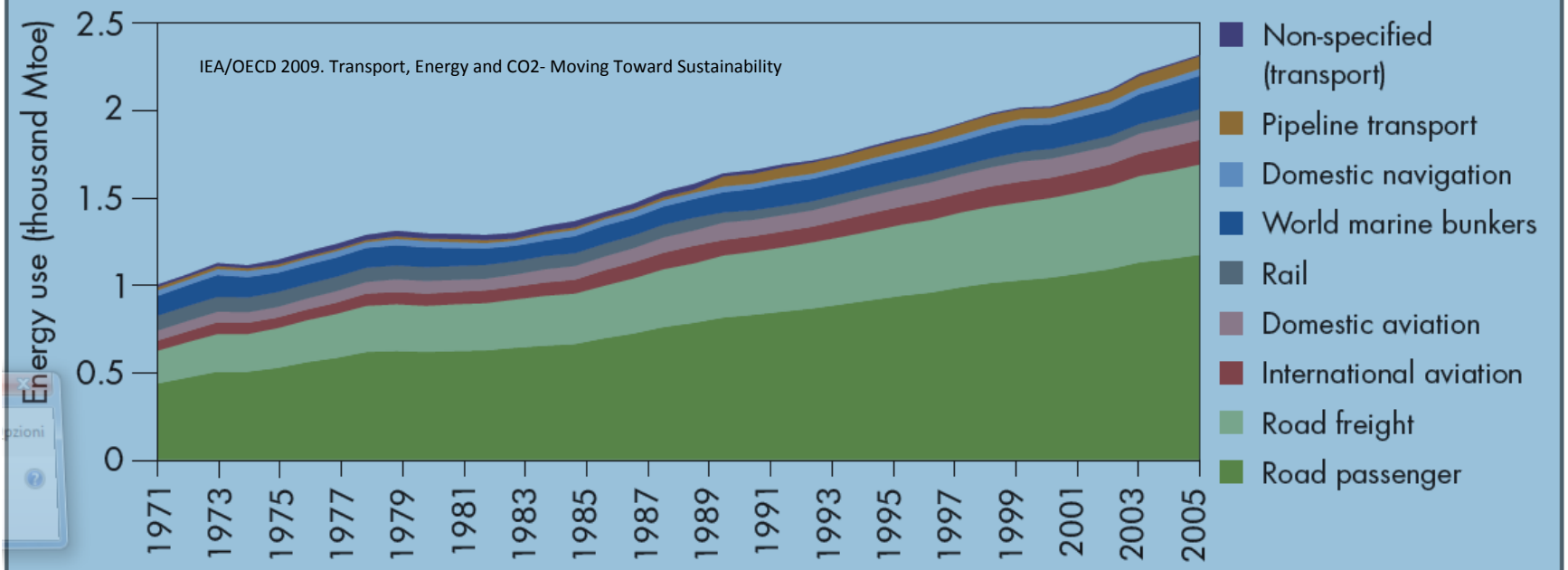
Figure 1.1 ▶ World transport energy use by mode, 1971-2006



Key point

Transport energy use has more than doubled since 1971, and has been dominated by road transport.

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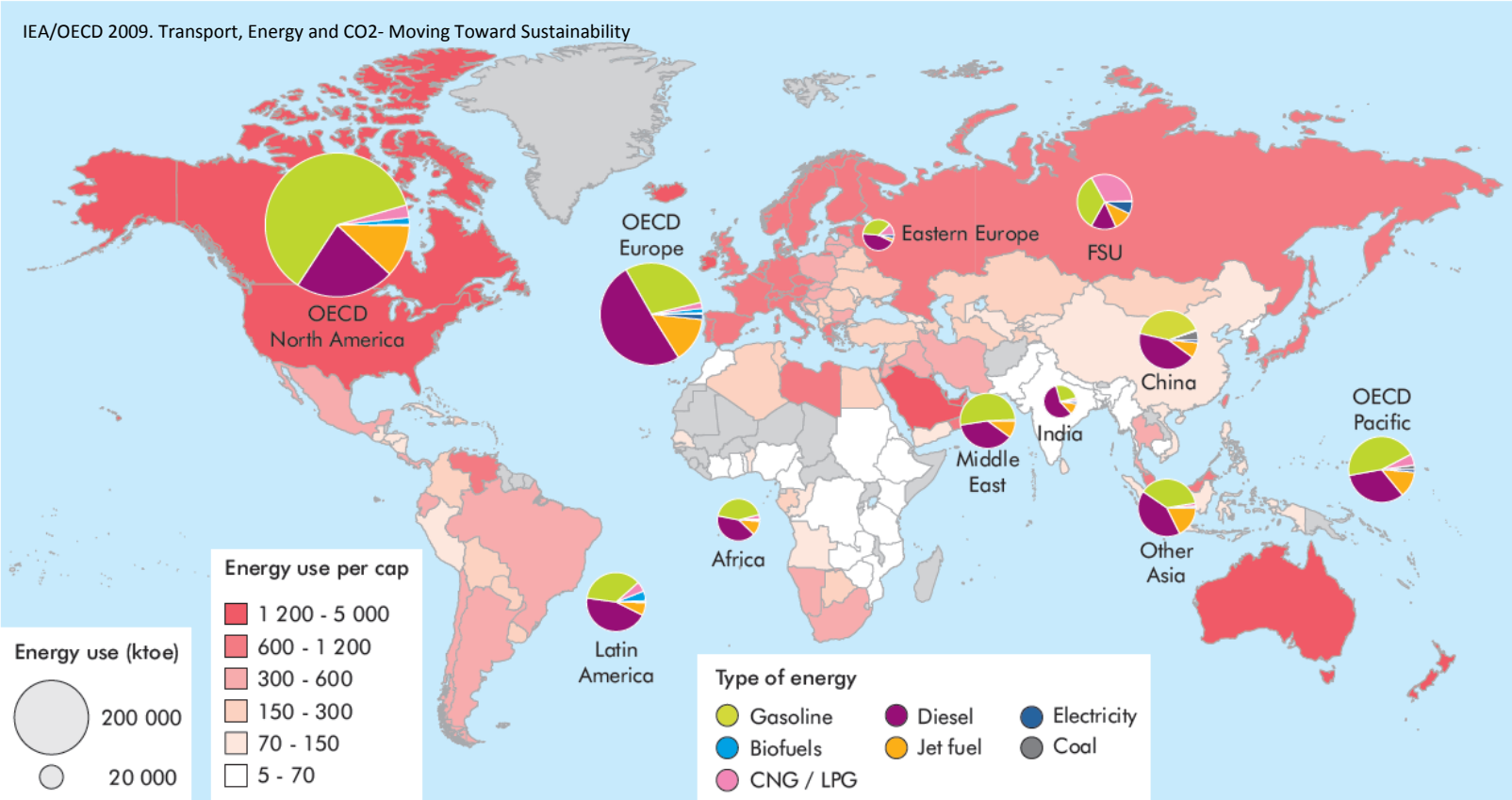
Figure 1.2 ▶ Transport sector energy use per capita, 2006



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Note: Does not include international shipping.

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Figure 1.4 ▶ Motorised passenger travel split by mode, 2005

IEA/OECD 2009. Transport, Energy and CO2- Moving Toward Sustainability

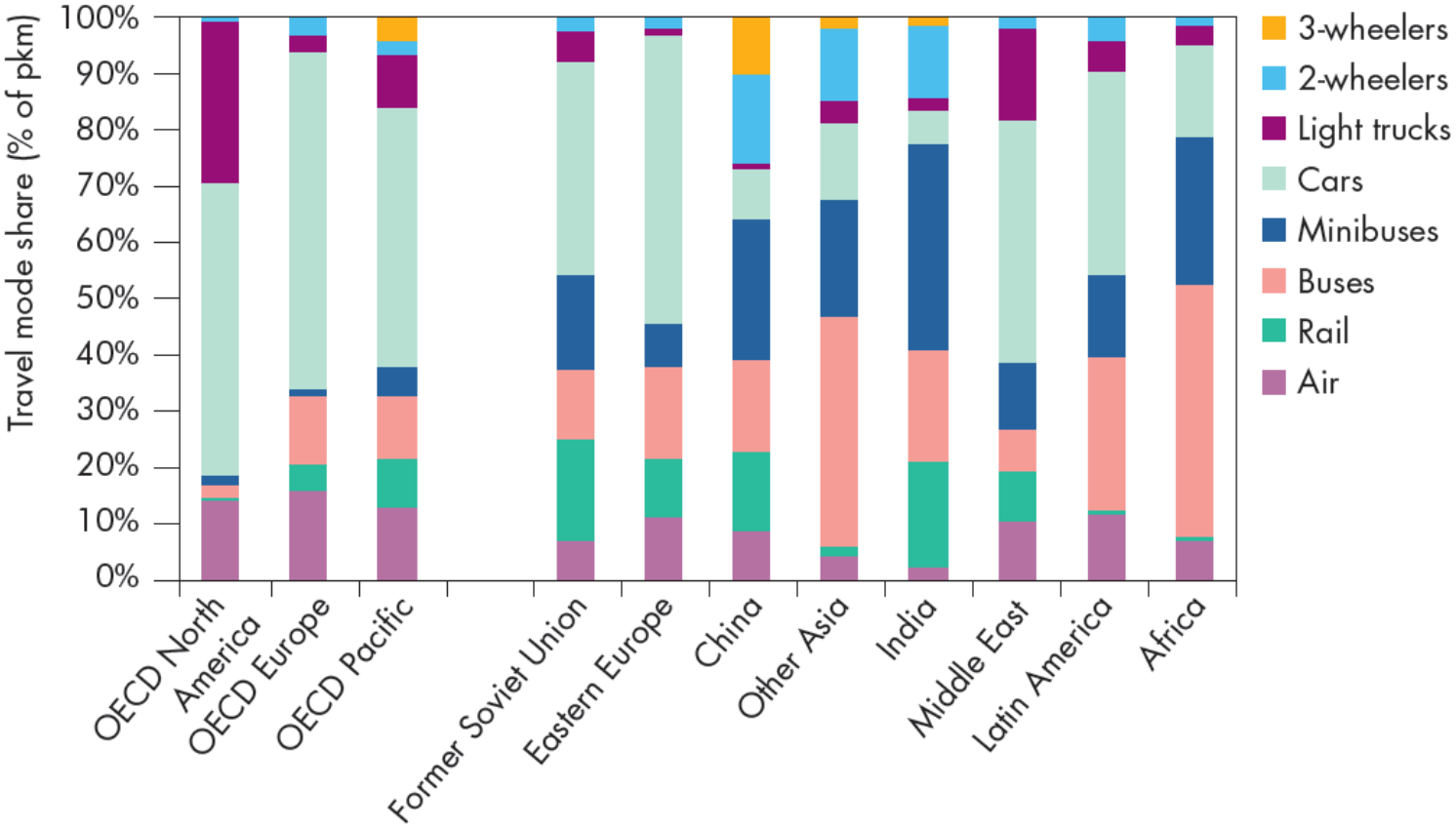

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Figure 1.5 ▶ Passenger LDV stock, by type and region, 2005

IEA/OECD 2009. Transport, Energy and CO2- Moving Toward Sustainability

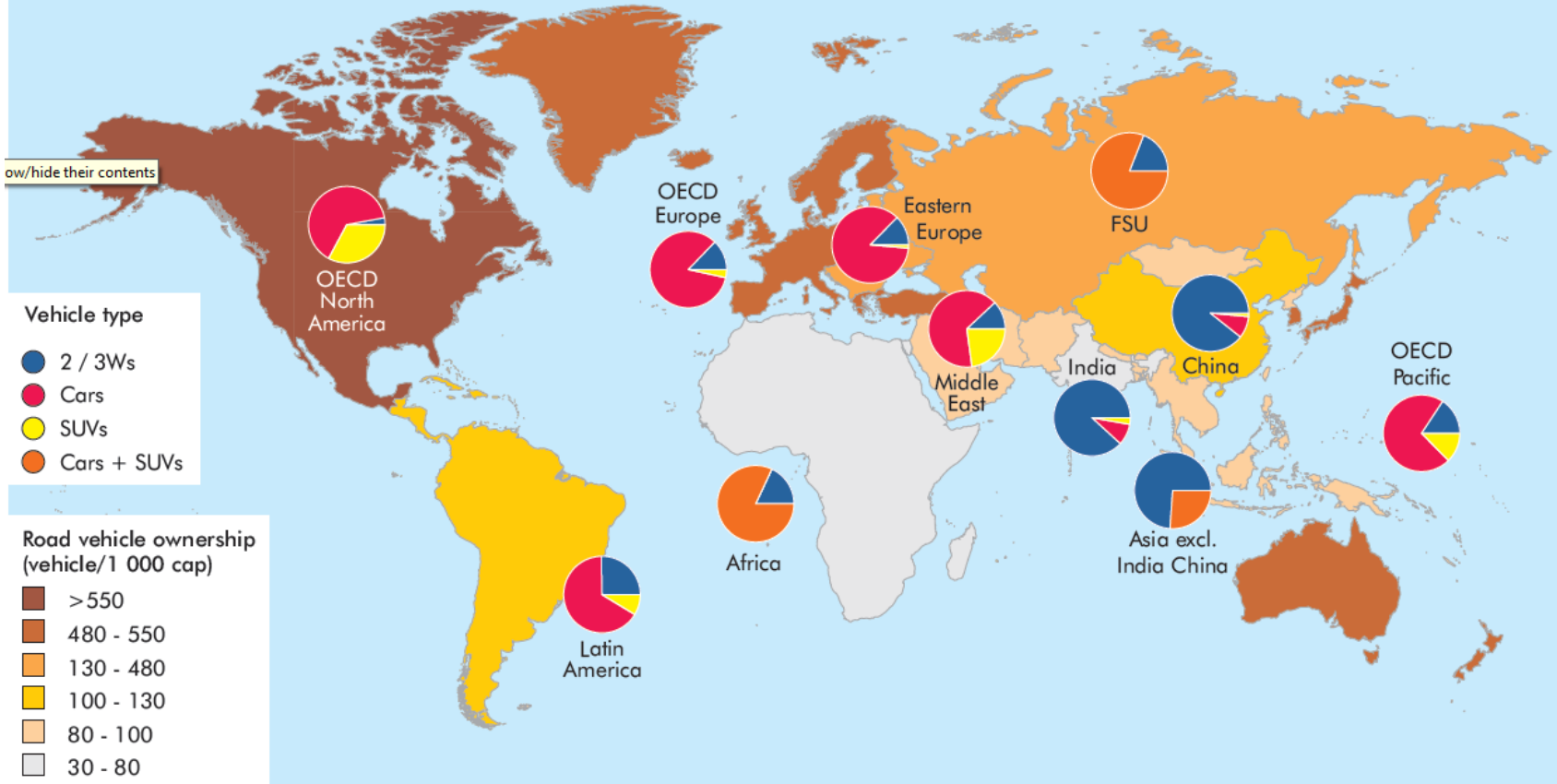

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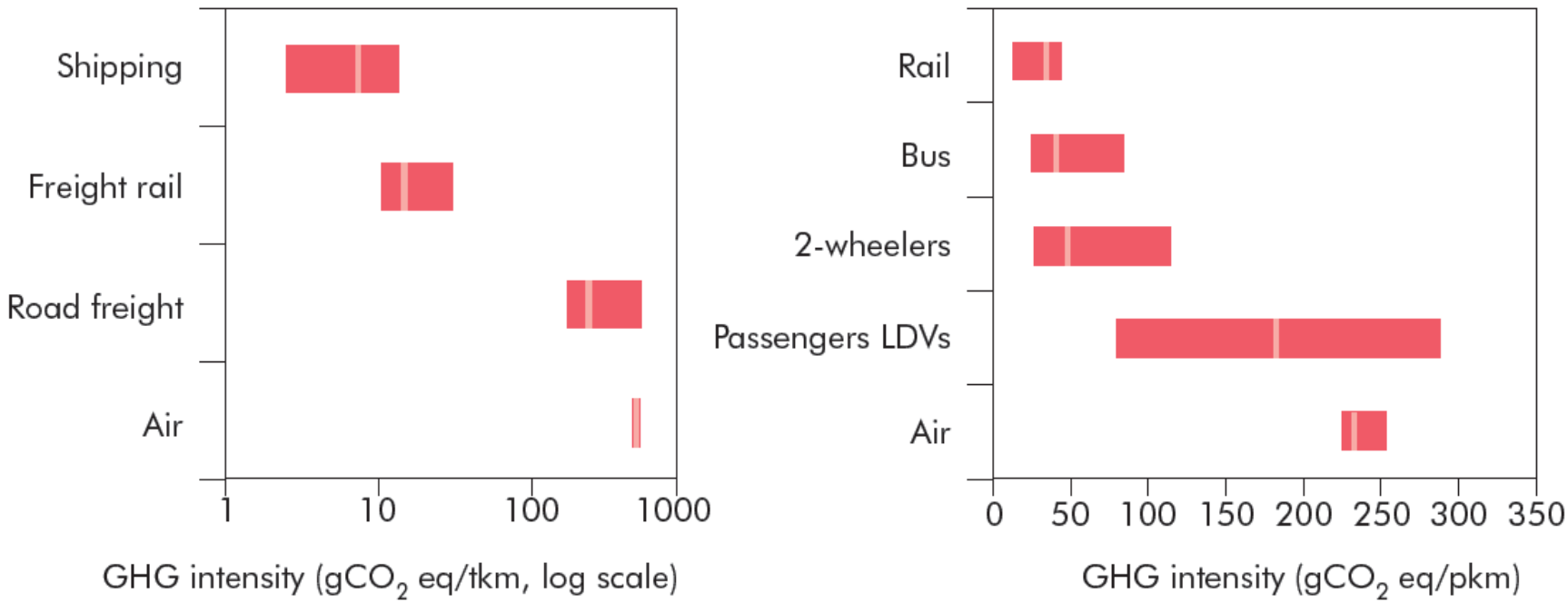
Figure 1.6 ▶ GHG efficiency of different modes, freight and passenger, 2005



Note: The clear line indicates world average, the bar representing MoMo regions' discrepancy.

Sources: IEA Mobility Model database; Buhaug (2008).

IEA/OECD 2009. Transport, Energy and CO2- Moving Toward Sustainability

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Urban Land use and transport

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Table 5.7 Survey results of travel patterns in the United States by residential location

	Urban	Inner suburb	Outer suburb
Cars per household	1.3	1.8	2.2
Number of destinations within 1 km	44.3	26.2	12.9
Mean distance to closest retail (km)	0.6	1.5	2.1
Non-auto modes used previous week			
■ Walked to work	33%	4%	2%
■ Walked to do errands	47%	20%	12%
■ Cycled	44%	24%	24%
■ Used transit	45%	12%	5%

Source: Horning, El-Geneidy and Krizek, 2008.

IEA/OECD 2009. Transport, Energy and CO2- Moving Toward Sustainability

Urban Land use and transport

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Table 5.8 ▶ **Urban design factors affecting traffic activity**

Factor definition	Definition	Travel impacts
Density	People or jobs per unit of land area (e.g. hectare)	Increased density => lower vehicle travel. Each 10% increase in urban densities typically reduces per capita vehicle kilometres of travel by 1% to 3%.
Mix	Degree that related land uses (housing, commercial) are located together. Sometimes measured as jobs/housing balance, the ratio of jobs and residents in an area	Increased land-use mix => lower vehicle travel and increase use of alternative modes, particularly walking for errands. Neighbourhoods with good land-use mix typically have 5% to 15% lower vehicle km of travel per capita.
Regional accessibility	Location of development relative to regional urban centre. Often measured as the number of jobs accessible within a certain travel time (e.g. 30 minutes)	Improved accessibility => lower vehicle travel. Residents of more central neighbourhoods typically drive 10% to 30% fewer vehicle kilometres than urban fringe residents.
Centeredness	Portion of commercial, employment and other activities in major activity centres	Greater centeredness => reduced vehicle travel and increased use of alternative commute modes. Typically 30% to 60% of commuters to major commercial centres use alternative (non-personal vehicle) modes, compared with 5% to 15% of commuters to dispersed locations.
Connectivity	Degree that roads and paths are connected and allow direct travel between destinations. Also relates to connectivity with transit systems and bicycle routes for easy transfers.	Improved connectivity => reduced vehicle travel, and improved walkway/cycle route/transit station connectivity tends to increase use of these modes.
Roadway design and management	Scale and design of streets, and how various uses are managed to control traffic speeds and favour different modes and activities.	Reduction in car-orientation (e.g. more multi-modal oriented streets) => increased use of alternative modes. Traffic calming measures that reduce vehicle speeds tend to reduce vehicle travel and increase walking and cycling.

Table 5.8 ▶ **Urban design factors affecting traffic activity**

Factor definition	Definition	Travel impacts
Walking and cycling conditions	Quality of walking and cycling transport conditions and infrastructure, including the quantity and quality of sidewalks, crosswalks, paths and bicycle lanes and the level of pedestrian security	Improved walking and cycling conditions => increased NMT and reduced automobile travel. Residents of more walkable communities typically walk 2-4 times as much and drive 5% to 15% less than if they lived in more automobile-dependent communities.
Transit quality and accessibility	The quality of transit service and the degree to which destinations are accessible by quality public transit in an area	Improved transit service => increased ridership and reduced automobile trips. Residents of transit oriented neighbourhoods tend to own 10% to 30% fewer vehicles, drive 10% to 30% fewer miles, and use alternative modes two to ten times more frequently than residents of automobile-oriented communities.
Site design	The layout and design of buildings and public spaces	More pedestrian friendly and multi-modal site design => reduced automobile trips, particularly if implemented with improved transit services.
Mobility management	Various programmes and strategies that encourage more efficient travel patterns. Also called "Transportation Demand Management" (TDM).	Mobility management => reduced vehicle travel for affected trips. Vehicle travel reductions of 10% to 30% are achievable through comprehensive TDM programmes.

Source: Adapted from Litman, 2008.

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Public transport and density

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Public transport needs a reasonably dense population in order to be effective. Cost-effective urban bus systems typically depend on a minimum density of 25 dwellings per hectare (dw/ha) (Banister, 2008). Due to its higher capacity, LRT needs at least 60 dw/ha. For comparison, the city of Paris has now an overall average of 150 dw/ha.

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Parking management and pricing

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- *Car drivers are willing to pay EUR 0.65 to get 100 m closer to their destination, or are ready for a three-minute search for a parking place in order to avoid a 200 m walk. Other studies have found that car drivers are willing to spend even longer to find a place as close as possible to their destination.*
- *Doubling parking costs decreases car mode share by about 20%.*
- *If parking costs are always at least the same as the public transport fare for regional trips up to about 40 km from the city centre, the share of car trips decreases by 8%.*
- *If the walking distance to and from a car is the same as that of a public transport alternative, the car mode share decreases by 13%.*
- *If all transit connections that include transfers are replaced by direct routes without transfer waiting and walking times, 10% of those car users that would have to make transfers if taking public transport (less than 20% of all respondents) would start to use public transport (thus, less than 2% overall).*

These results relate to particular cities at particular points in time, but may indicate an order of magnitude that may be relevant to other cities, especially those having similar characteristics.

Source: Cordis (2002).

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Car sharing

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Table 5.10 ▶ Car usage prior to and after subscribing to car-sharing schemes

	Prior to car-sharing (km/y)	When car-sharing (km/y)	Proportion of total users
Never car owners	0	1 000	25%
Former car owners	10 000	5 000	65%
Still car owners	10 000	9 000	10%
Average	7 500	4 400	100%

Source: Moses, 2005.

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Road pricing

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Table 5.13 ▶ Characteristics of several road-charging schemes

Town	Name	Date implemented	Scheme type	Area (km²)	Operating hours	Price	Enforcement system
Singapore	Electronic road pricing	1975	Cordon ring (in)	7	Mo-Sa 7.00 - 22.00	Gantry / time dependent EUR 0 to 1.5	Radiofrequencies + cameras
London	Congestion charge	2003	Cordon ring (in)	40	Mo-Fr 7.00-18.30	Flat rate, GBP 8/day	CCTV cameras
Stockholm	Congestion tax	2006 (became permanent in 2007)	Cordon ring (in and out)	35	Mo-Fr 6.30-18.30	EUR 1 to 2/crossing depending on time of day	Laser + cameras
Milan	Ecopass	2008 (temporary through end of 2009; extension possible)	Cordon ring (in)	8	Mo-Fr 7.30-19.30	EUR 2 to 10/day	Digital cameras

Note: For scheme type, "in and out" means that in Stockholm the cordon ring requires payment for both entering and exiting.

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BRT and CDM

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Box 5.8 ▶ BRT and the Clean Development Mechanism (CDM)

Annex B countries of the Kyoto Protocol are allowed through the CDM to get credit for financing projects to reduce CO_2 emissions in developing countries as an alternative to more expensive emission reductions in their own countries. Up to 2008, few transport projects have been approved, and only one related to developing BRT or passenger modal shifting. In 2006, the first successful project for Bogota's TransMilenio Phase II was approved, allowing CDM financing by Switzerland and the Netherlands. Several other BRT initiatives have started the implementation process in 2008/09. Table 5.15 below indicates applications and their known status.

Table 5.15 ▶ BRT systems linked with CDM schemes

Country	Cities	BRT launch year	CDM implementation date	Parties involved
Columbia	Bogota	2000	2006	Switzerland, The Netherlands
	Pereira	2006	2009 (in validation)	The Netherlands
	Cali	2009	2010	The Netherlands
	Medellin	2009	2010	
Ecuador	Quito	1995		
China	Chongqing	2009	2009 (in validation)	The Netherlands
	Hangzhou	2010		
	Xiamen	2010		
	Jinan	2010		
	Dalian	2010		
India	Delhi	2010		
	Mumbai	2010		

Source: GTZ, 2007; Grutter Consulting, 2009.

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cycling

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Table 5.18 Correlation between cycling infrastructure funding and cycling overall mode share

	Annual funding (USD per resident)	Cycling mode share
United States	1.5	1%
Portland (city in Western US)	3.5	4%
Berlin	6.0	10%
Copenhagen	13.0	20%
Amsterdam	39.0	35%

Source: Rails-to-Trails, 2008.

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Bike-sharing in Europe

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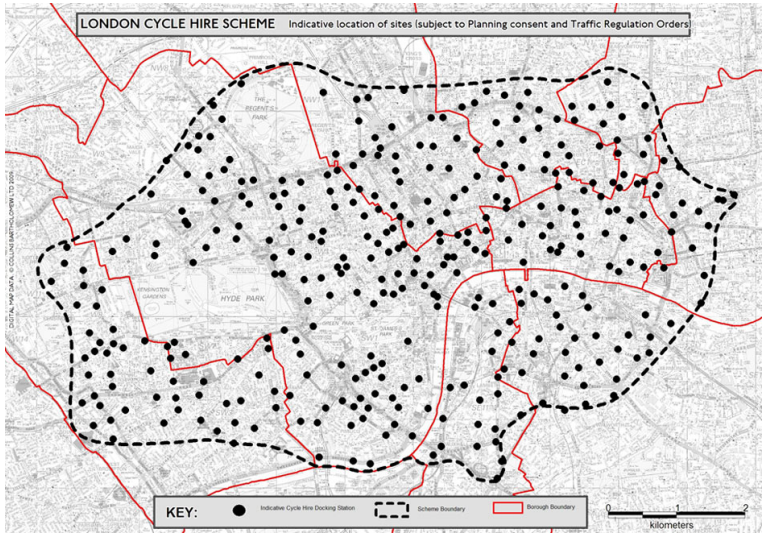
Table 5.19 On-street bicycle rental service around the world, 2009

France			Rest of the World		
City	Year of launch	Number of bicycles	City	Year of launch	Number of bicycles
Aix-en-Provence	2007	200	Brussels	2006	250
Amiens	2008	313	Barcelona	2007	6 000
Besançon	2007	200	Córdoba	2004	35
Caen	2008	350	Dublin	2009	500
Cergy-Pontoise	2008		Gijon	2004	53
Dijon	2008	400	Gothenberg	2009	150
Lyon	2005	4 000	Luxembourg	2008	200
Marseille	2007	1 000	Milan	2008	1 400
Mulhouse	2007	200	Oslo	2006	1 200
Nantes	2008	700	San Francisco	2008	120
Paris	2007	20 600	Zaragoza	2008	400
Perpignan	2008	150	Sevilla	2007	2 500
Plaine-Commune	2009	450	Stockholm	2006	1 000
Rennes	1998	200	Vienna	2004	500
Rouen	2007	175	Washington DC	2008	150
Toulouse	2007	1 470			

Note: In the Paris region there will be 25 000 bicycles available by the end of 2009 once the Velib system is extended to the cities immediately surrounding Paris.



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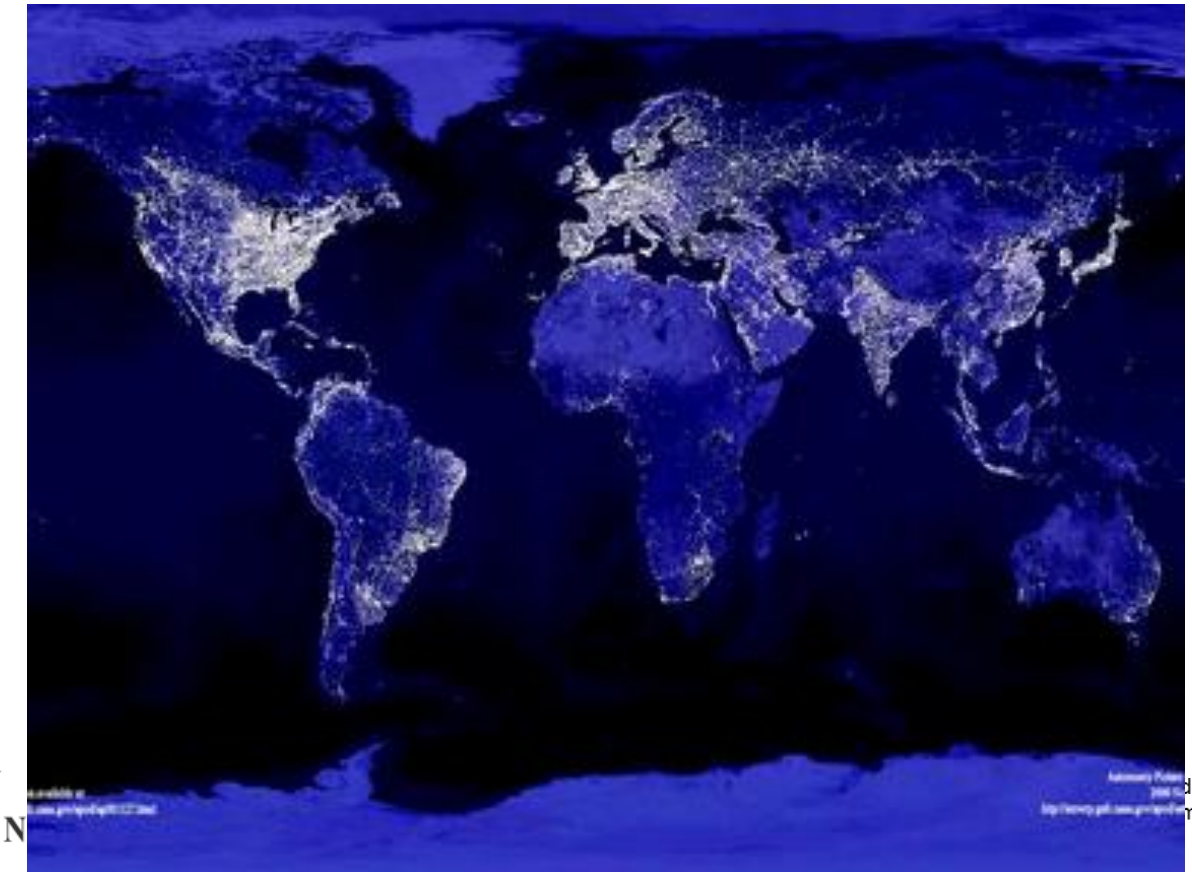
- Vedi pp 237-270 urban policies

Consumo di energia

- Consumo medio annuo in tonnellate di petrolio equivalente
  - Cittadino americano 9 t
  - Cittadino europeo 4 t
  - Cittadino del Mali 21 kg



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