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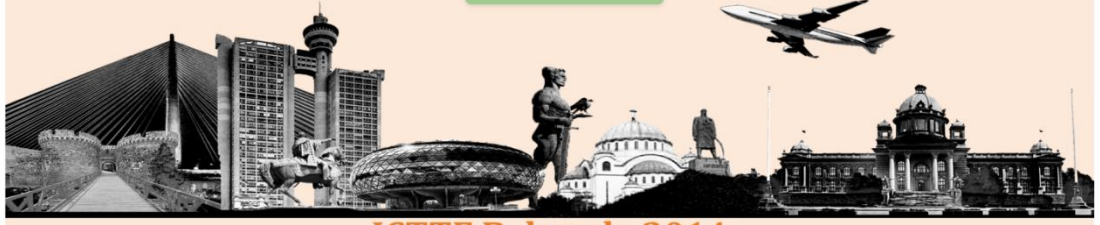
CeNSU Centro Nazionale Studi Urbanistici



ICTTE Belgrade 2014

INTERNATIONAL CONFERENCE ON TRAFFIC AND TRANSPORT ENGINEERING

27th – 28th November 2014, Belgrade (Serbia)

SPECIAL
SPATIAL PLANNING and ENERGY for COMMUNITIES IN ALL LANDSCAPES

ASSOCIAZIONE ITALIANA per l'INGEGNERIA del TRAFFICO e dei TRASPORTI

AIIT

ANALYSIS OF LAND USE AND MOBILITY SCENARIOS FOR THE REDUCTION OF TRANSPORT ENERGY IN THE URBAN AREA OF CATANIA

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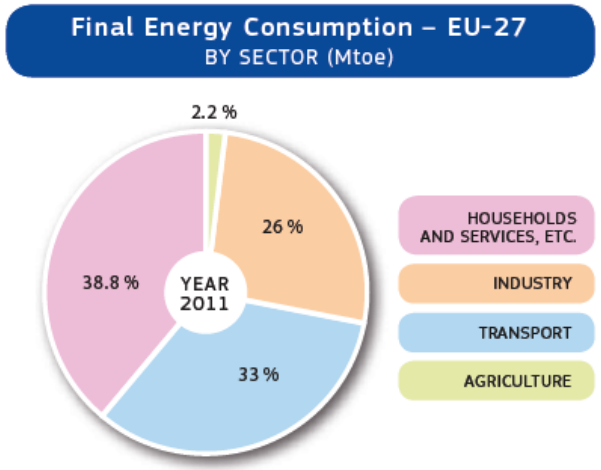
Research objectives

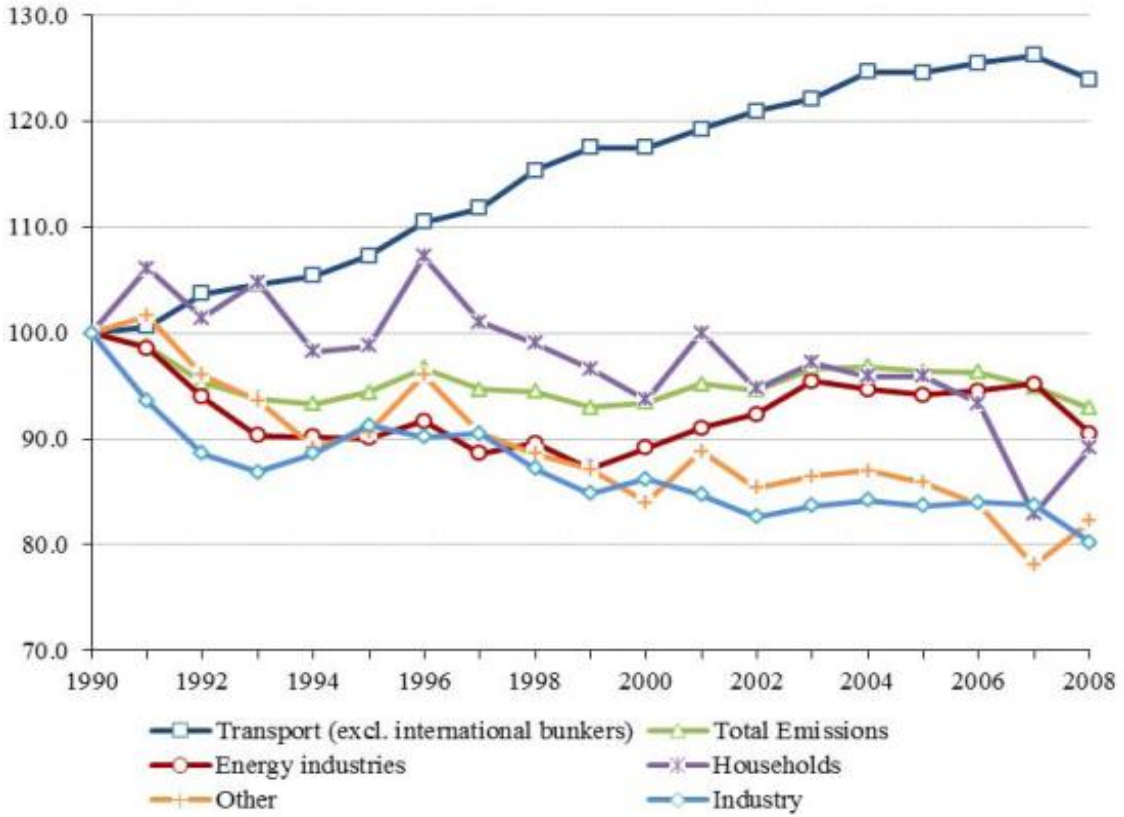
- Highlight the impact of transport on energy sustainability of urban areas
- Set up a methodology to calculate a transport energy indicator to support the delivery of sustainable land use and delivery of land use and transport urban plans
- Test the methodology in a case study

Transport Energy impacts

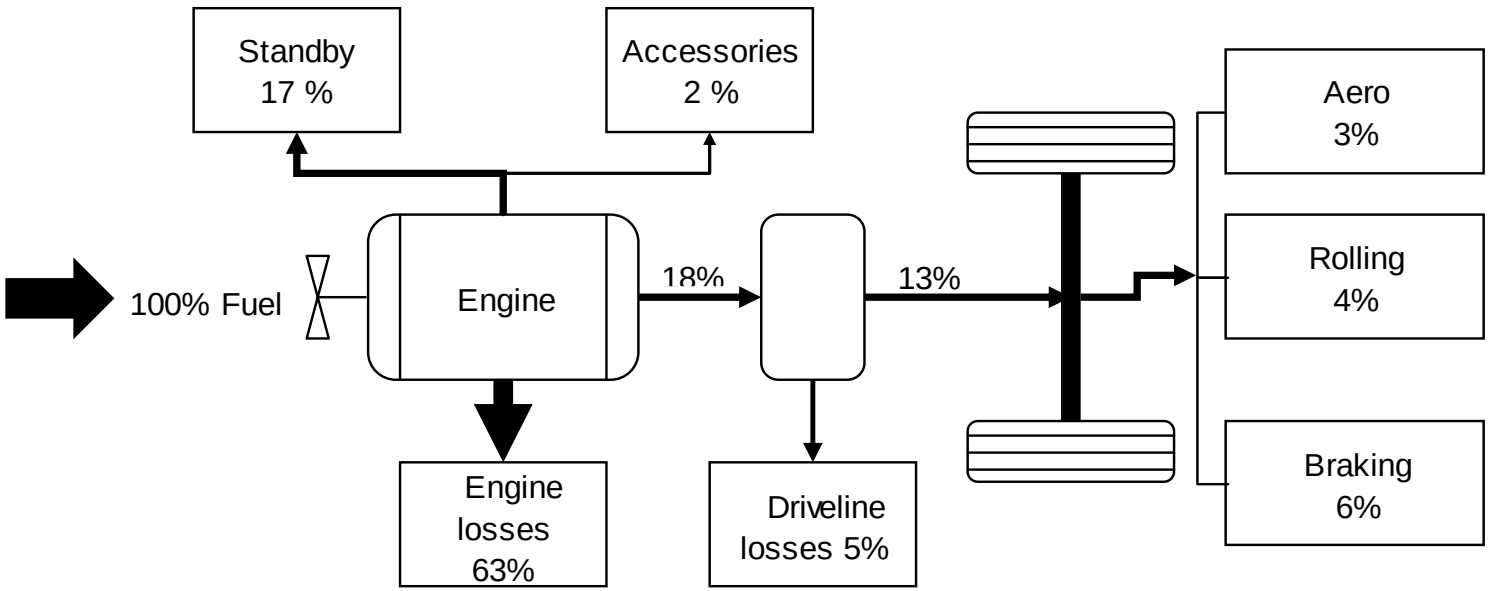
- 1/3 of energy
- 70% of oil
- 25% of CO2 emissions
- 2.5% average rate growth

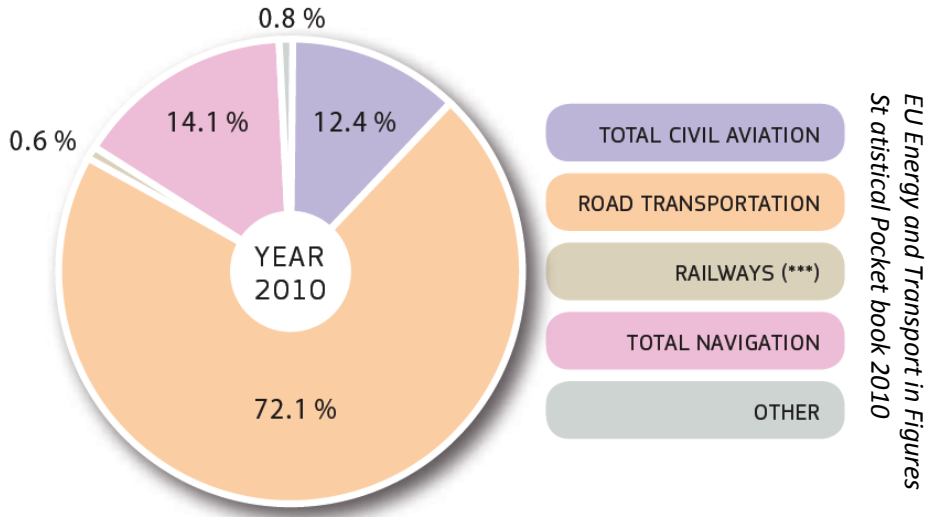


EU Energy and Transport in Figures St atistical Pocket book 2013



Transport Energy Efficiency

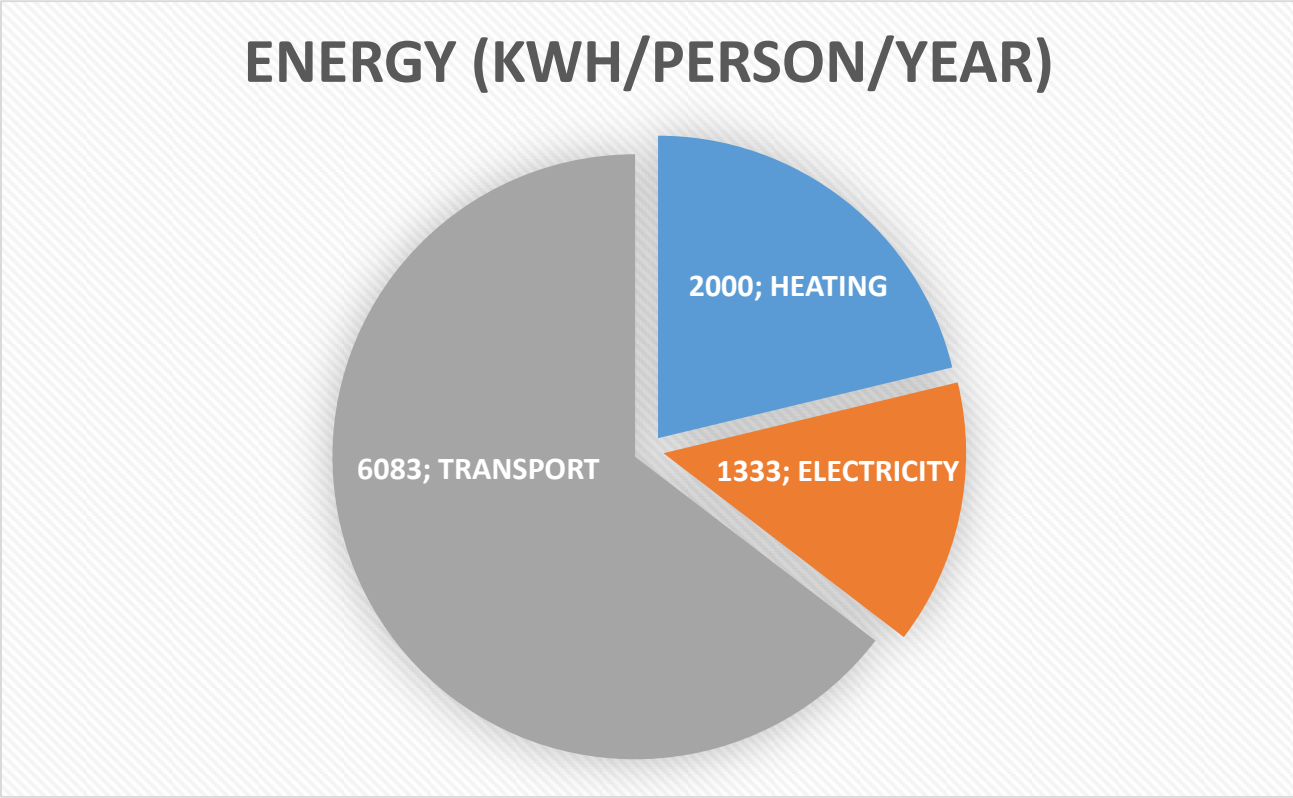


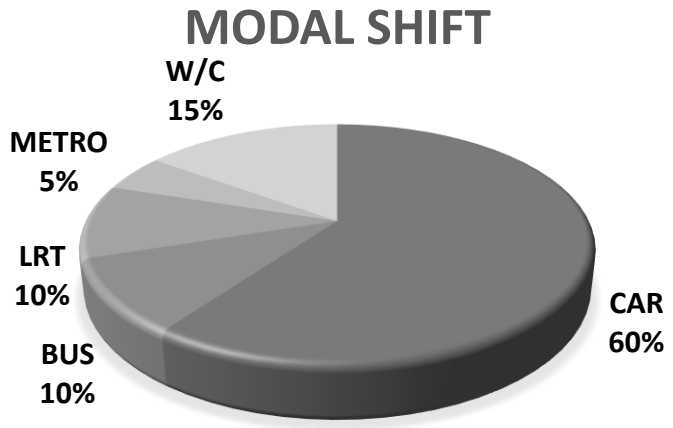


EU Energy and Transport in Figures
St atistical Pocket book 2010

INTRINSIC ENERGY INEFFICIENCY OF CARS
less than 2% of consumed energy is used by the payload

Urban Energy Demand

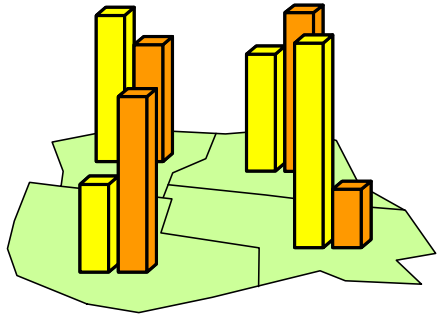




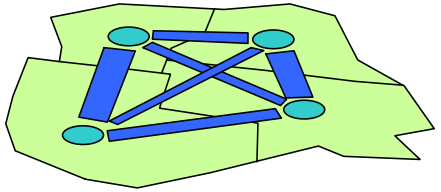
- 10.000 km/pers/year
- 100 kwh/year/mq (including cooling and lighting)
- Waste management and urban deliveries not included

http://www.passivhaushomes.co.uk/whatisph.html

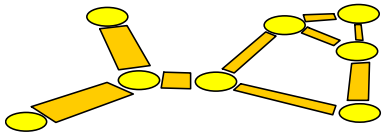
How to reduce urban transport energy demand



Land Use



Spatial Interactions



Transportation Network

Land Use Efficiency

Vehicle Efficiency

$$E_t[kWh] = Persons\ [pax] \times Dis\tan ce[km] \times \frac{Vehicle\_unit\_consumption\ [kWh/km]}{Vehicle\_capacity\ [pax] \times Load\_factor\ [\%]}$$

Transport System Efficiency

Efficienza Energetica Globale

$$kWh = (pax - km) \cdot \left(\frac{veic}{pax}\right) \cdot \left(\frac{kWh}{veic - km}\right)$$

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RIDURRE	CAMBIARE	MIGLIORARE
Efficienza del territorio	Efficienza dei trasporti	Efficienza dei veicoli
• Integrare uso del 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/km**
Pianificazione territoriale	Pianificazione dei trasporti	Innovazione tecnologica

$$kWh = (trasporto) \cdot (ineff\_trasporto) \cdot (consumo\_veic)$$

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Urban density and transport energy

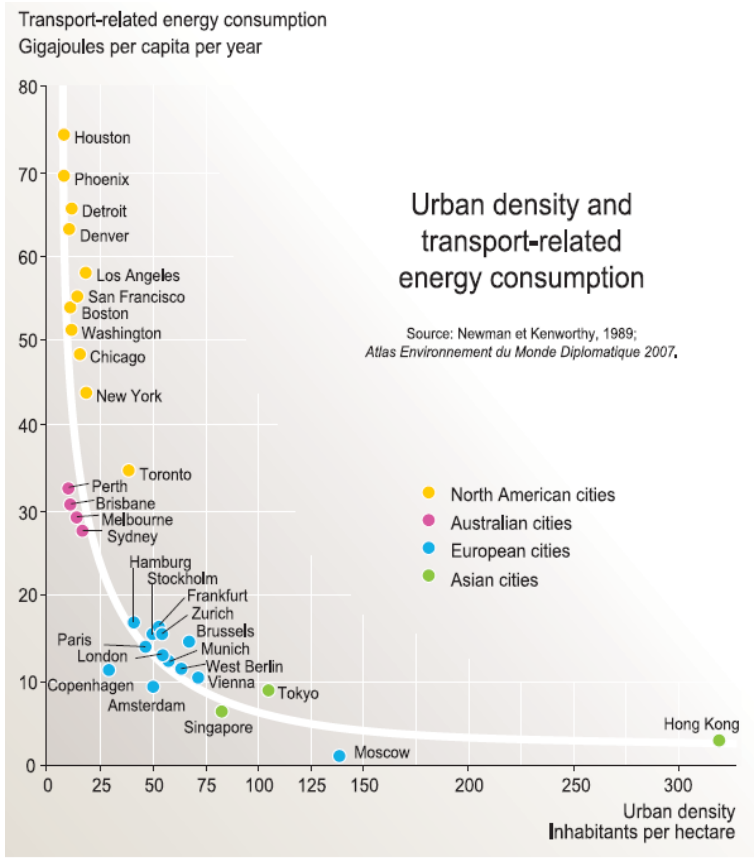


Figure 1 : The Newman and Kenworthy hyperbola: Urban density and transport-related energy consumption

Hong Kong

Houston

Average Density vs Spatial Dynamics

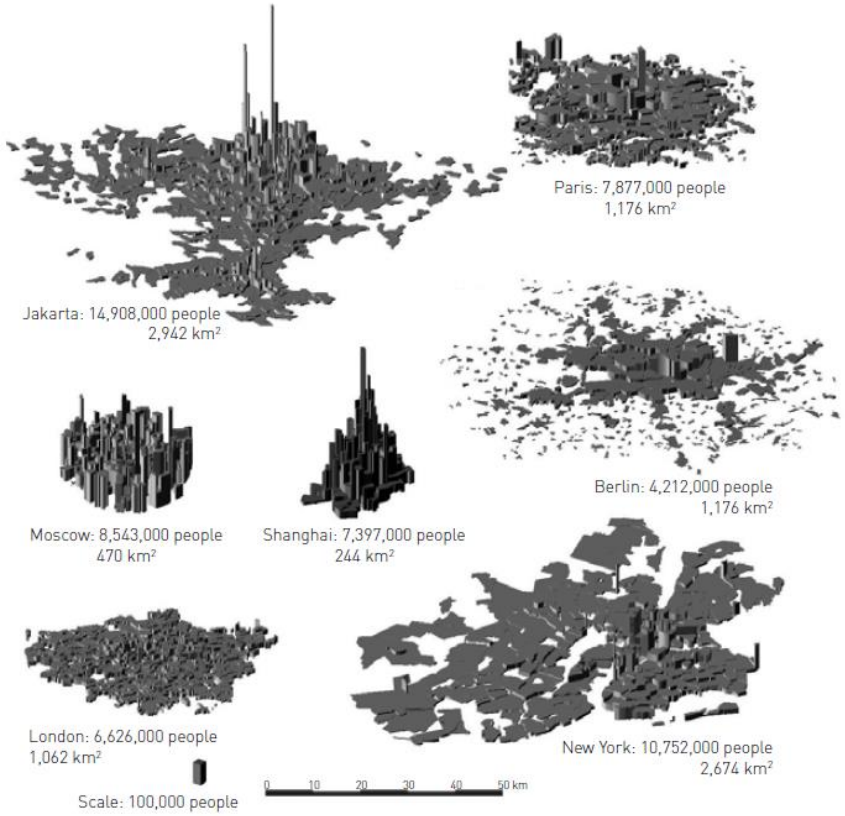
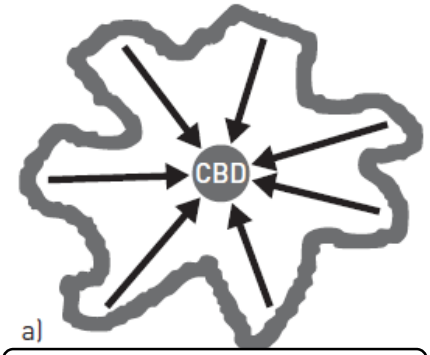
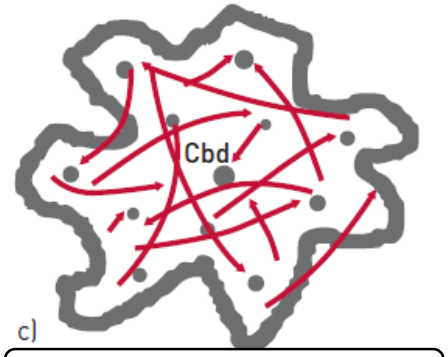


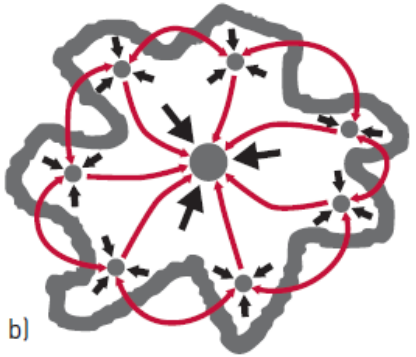
Figure 3. Residential density distribution in several cities. Source: (Bertaud, 2001).



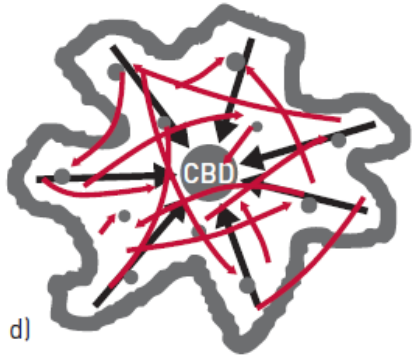
Radial monocentric



Random polycentric



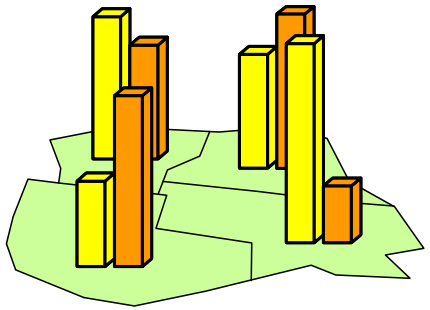
Urban village polycentric



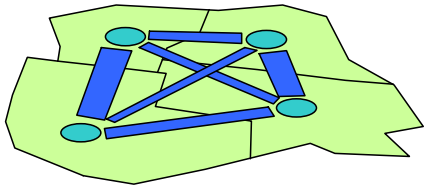
Random and radial mono-polycentric

Research Question | Methodology | Case Study | Results | Conclusions

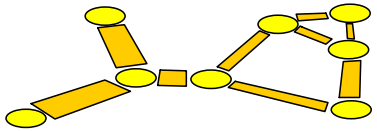
Land Use- Transport – Energy model



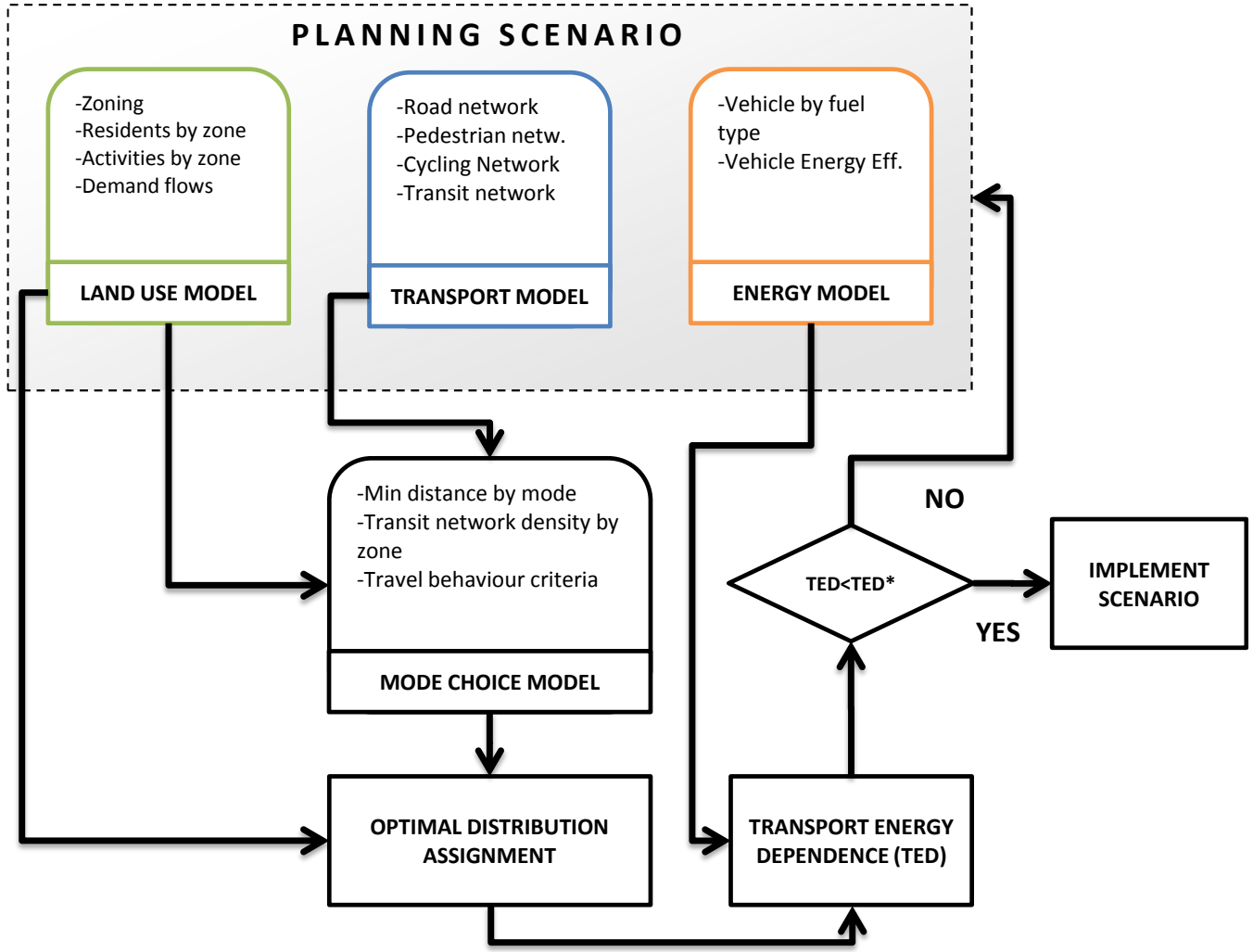
Land Use



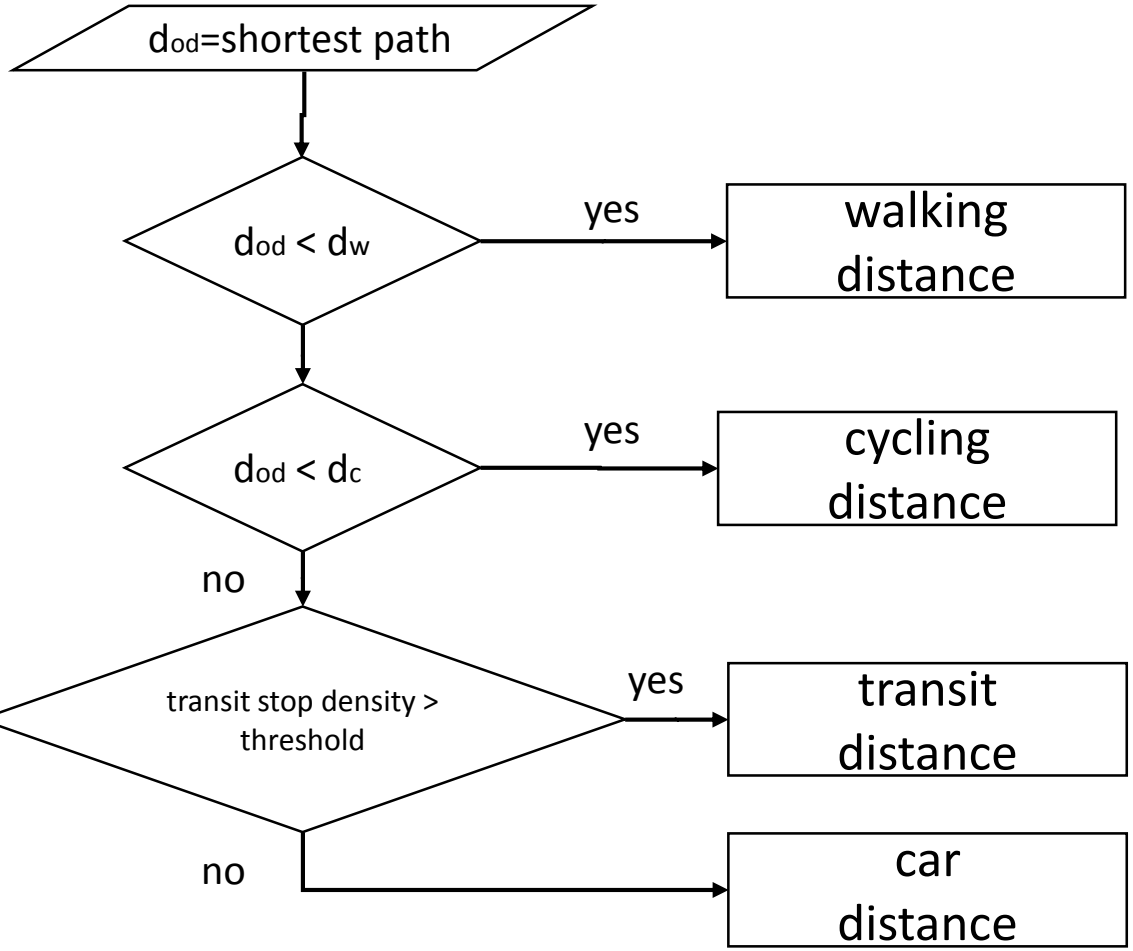
Spatial Interactions



Transportation Network



Transport mode choice model



TRANSIT DENSITY THRESHOLD		
BUS	6.67	Km/km²
LRT	3.30	Km/km²
METRO	2.50	Km/km²

Choice	Distance	
WALKING	<500m	dod
CYCLING	<1000m	dod
BUS	<300+300m	Stop access/egress
LRT	<600+600m	Stop access/egress
METRO	<800+800m	Stop access/egress

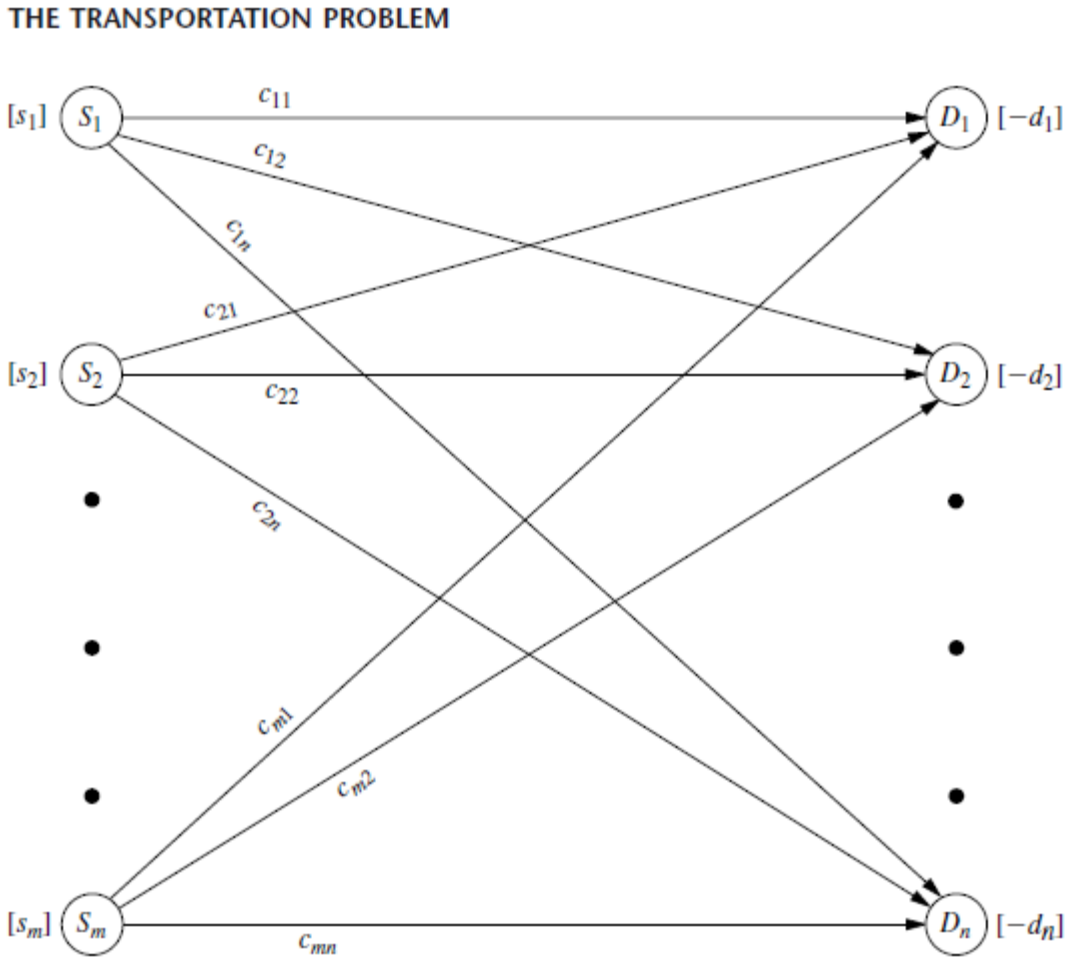
Optimal demand flows assignment

$$\min(Z) = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$$

$$\sum_{j=1}^{n} x_{ij} = s_i$$

$$\sum_{i=1}^{m} x_{ij} = d_j$$

$$x_{ij} \geq 0$$



Transport Energy Dependence

$$TED_s = \sum_o \sum_d \mathbf{X}_{ij}^{opt} \cdot t_{od} \cdot l_{od} \cdot \frac{e_v}{c_v \cdot LF_v} \cdot \mathbf{c}_{ij}$$

t_{od} number of trips assigned from zone o to zone d to minimize Z (passengers)

l_{od} shortest distance between zone o and zone d (km)

e_v unit energy consumption of the chosen transport mode (kWh/km)

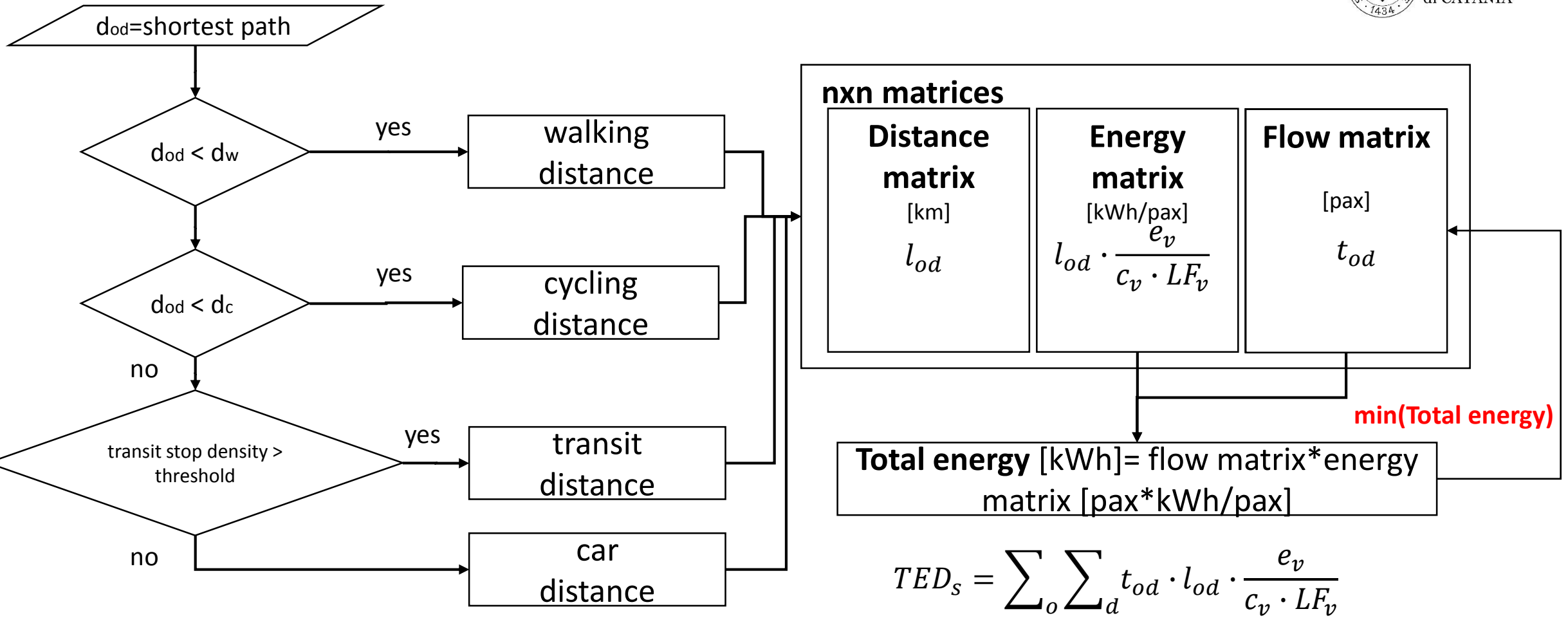
c_v capacity of the vehicle (spaces)

LF_v load factor (passengers/spaces)

Mode of transport	Unit energy consumption kWh/pax-km
Private Car	0.917
Regular Bus Transit	0.325
Bus Rapid Transit	0.192
Metro Transit	0.133

Kenworthy (2003)

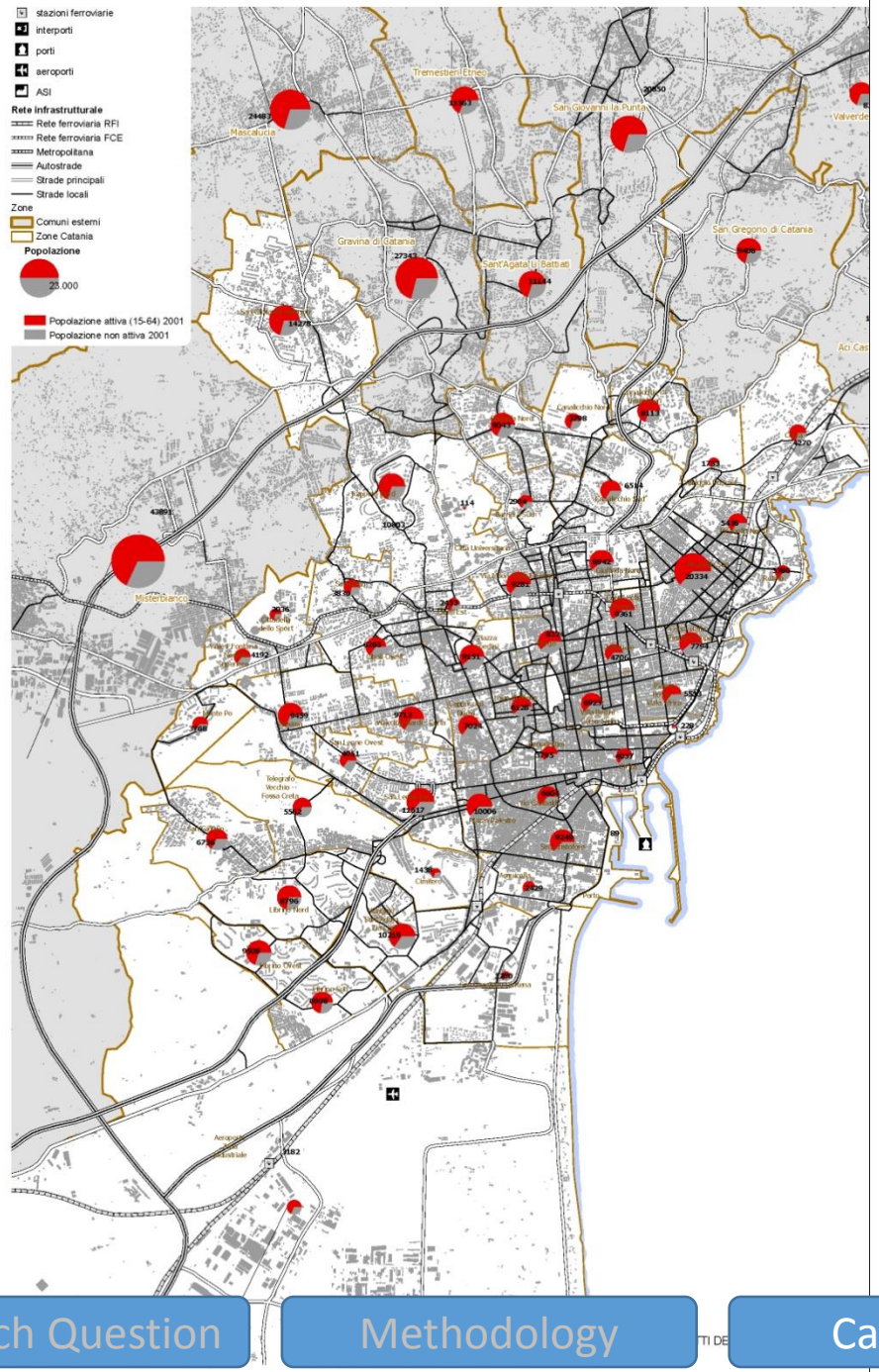
Optimal demand flows assignment (n zones)



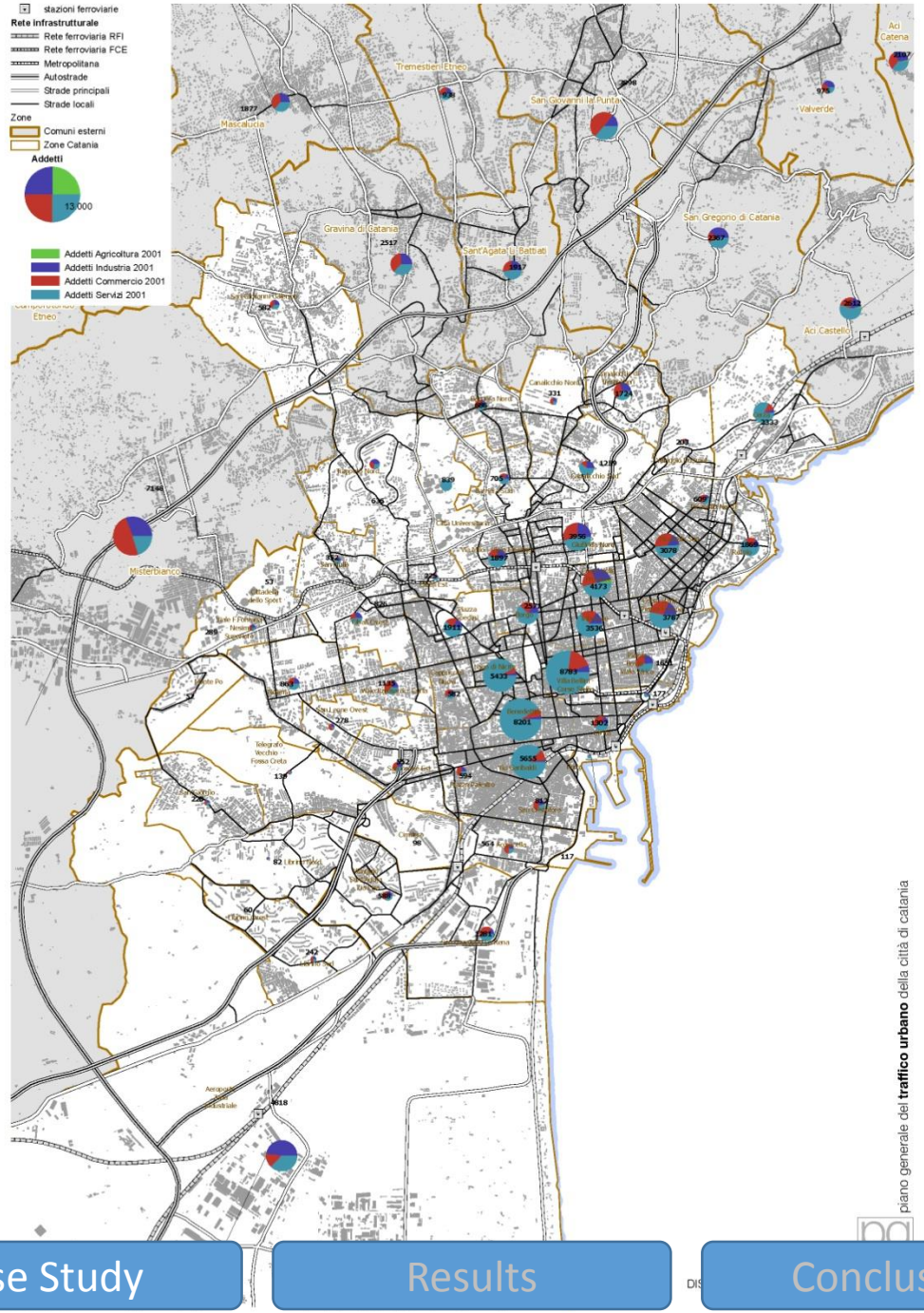
$$TED_s = \sum_o \sum_d t_{od} \cdot l_{od} \cdot \frac{e_v}{c_v \cdot LF_v}$$

Case Study - Catania

population

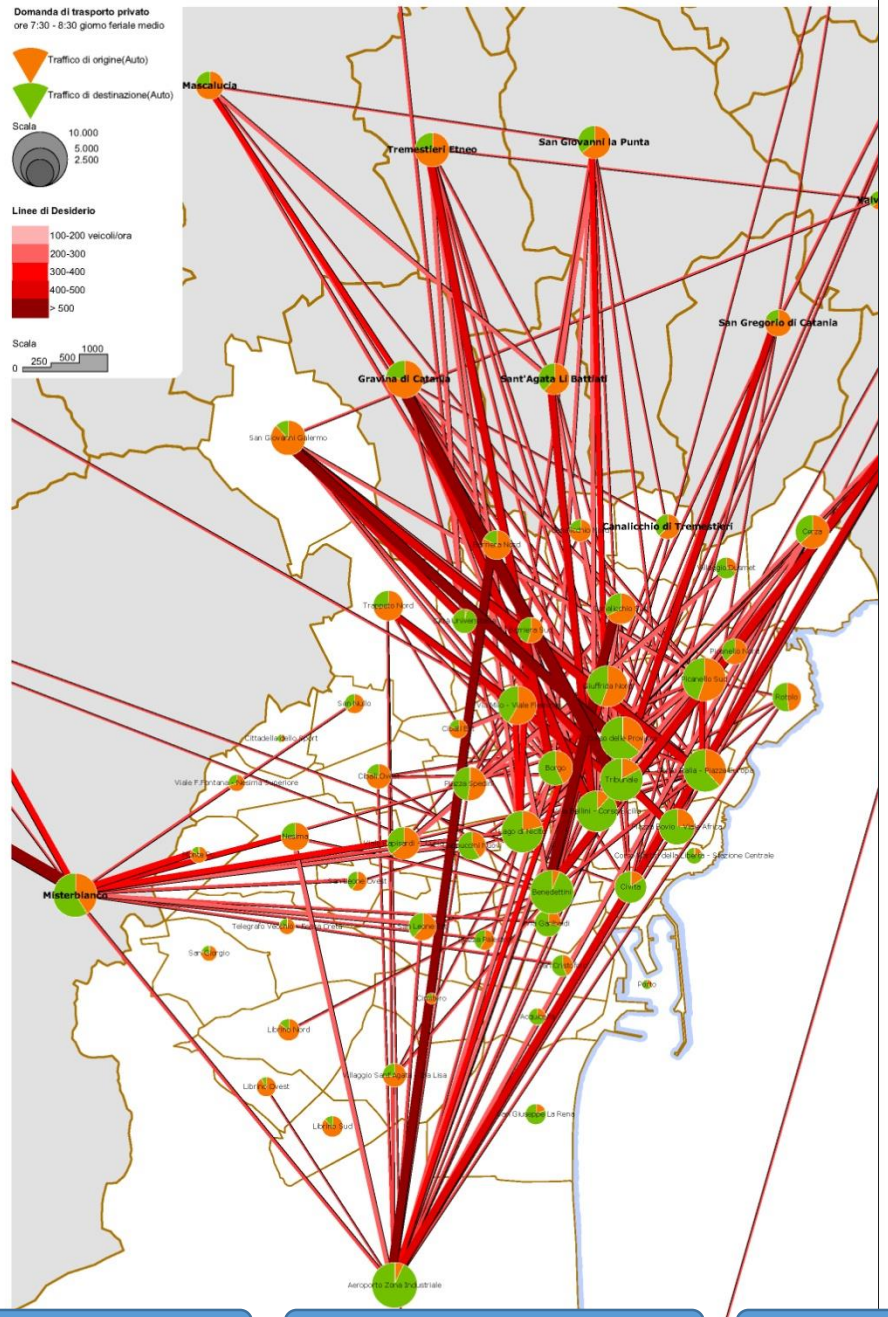


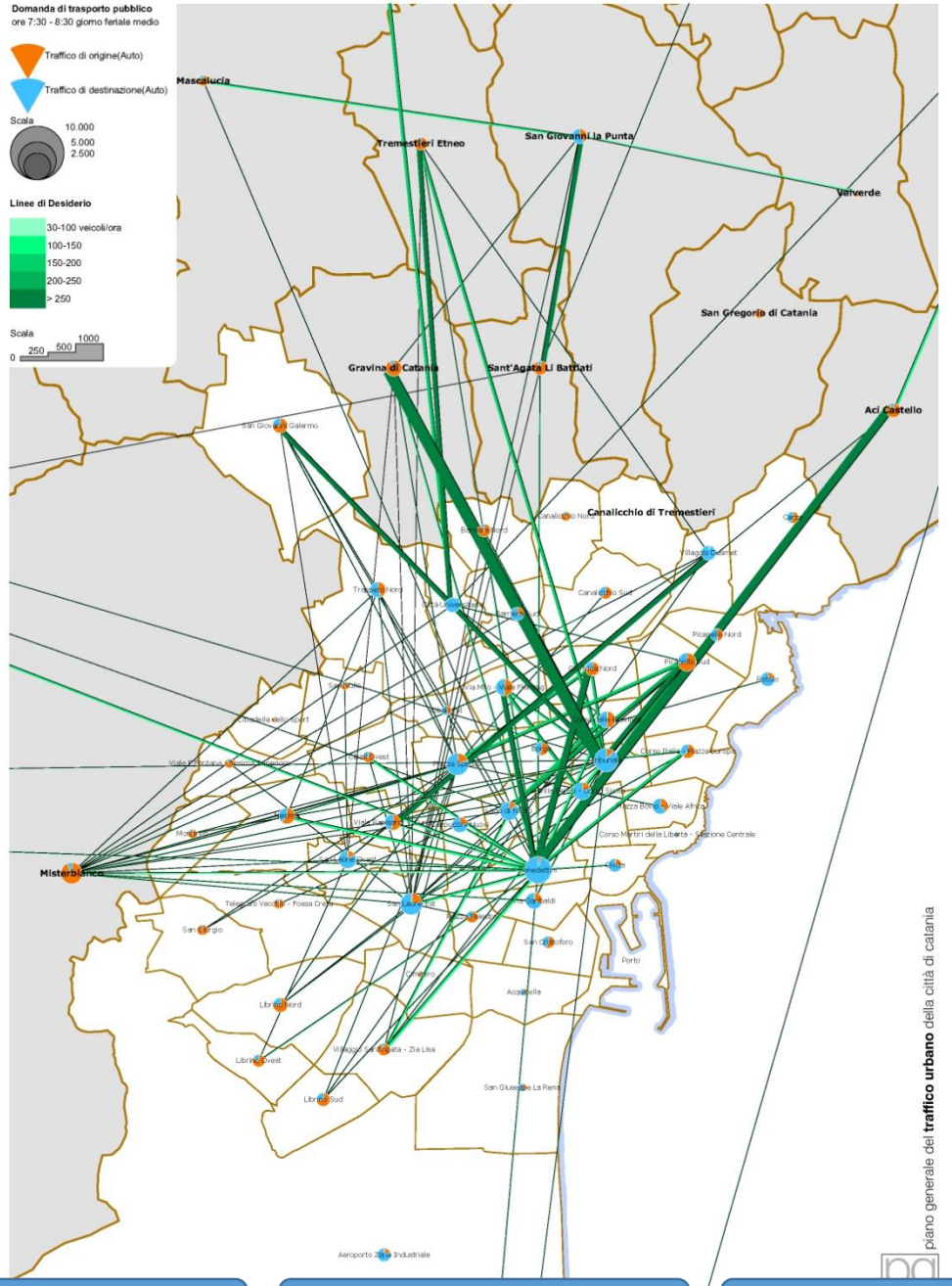
jobs



Research Question | Methodology | Case Study | Results | Conclusions

Private transport demand

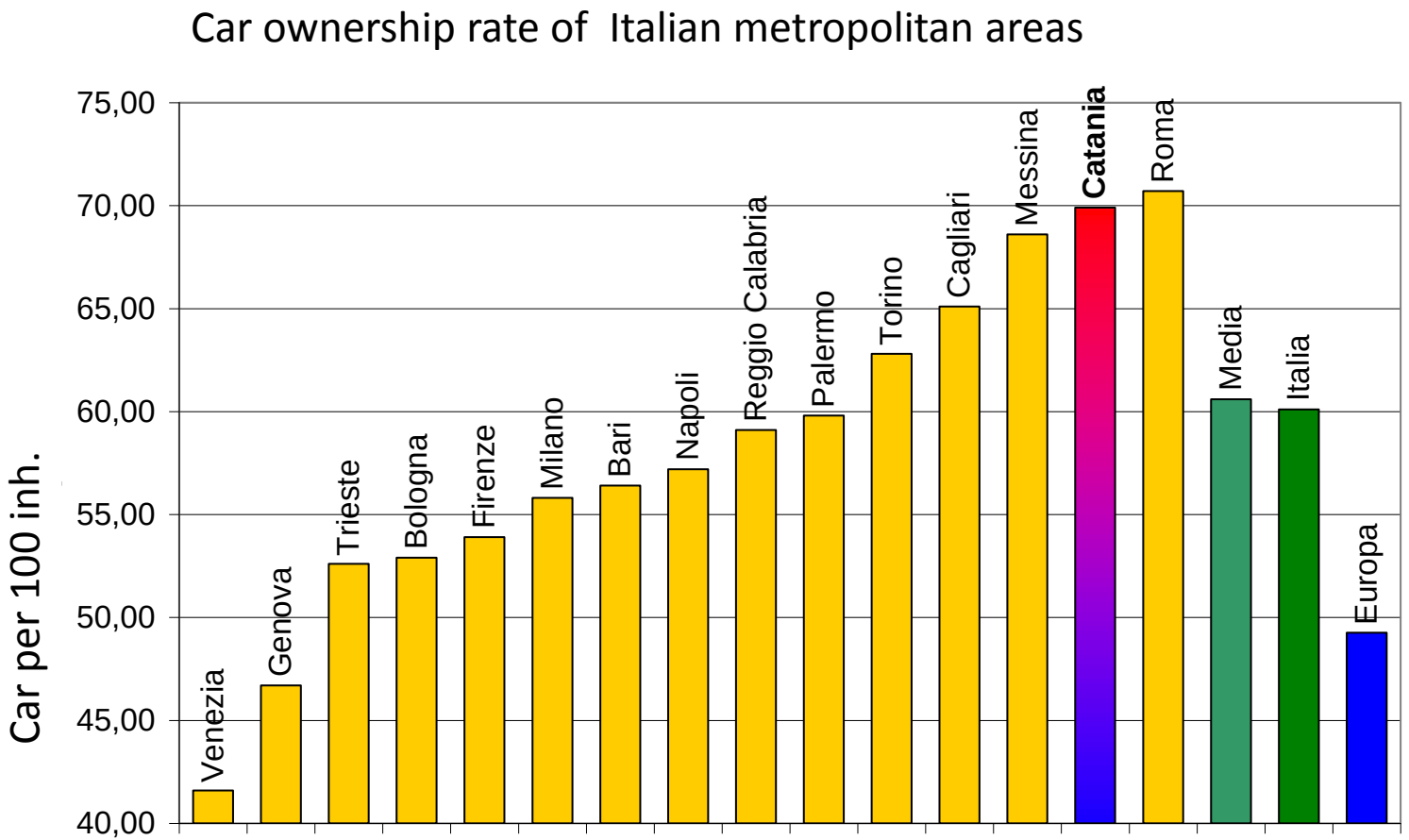




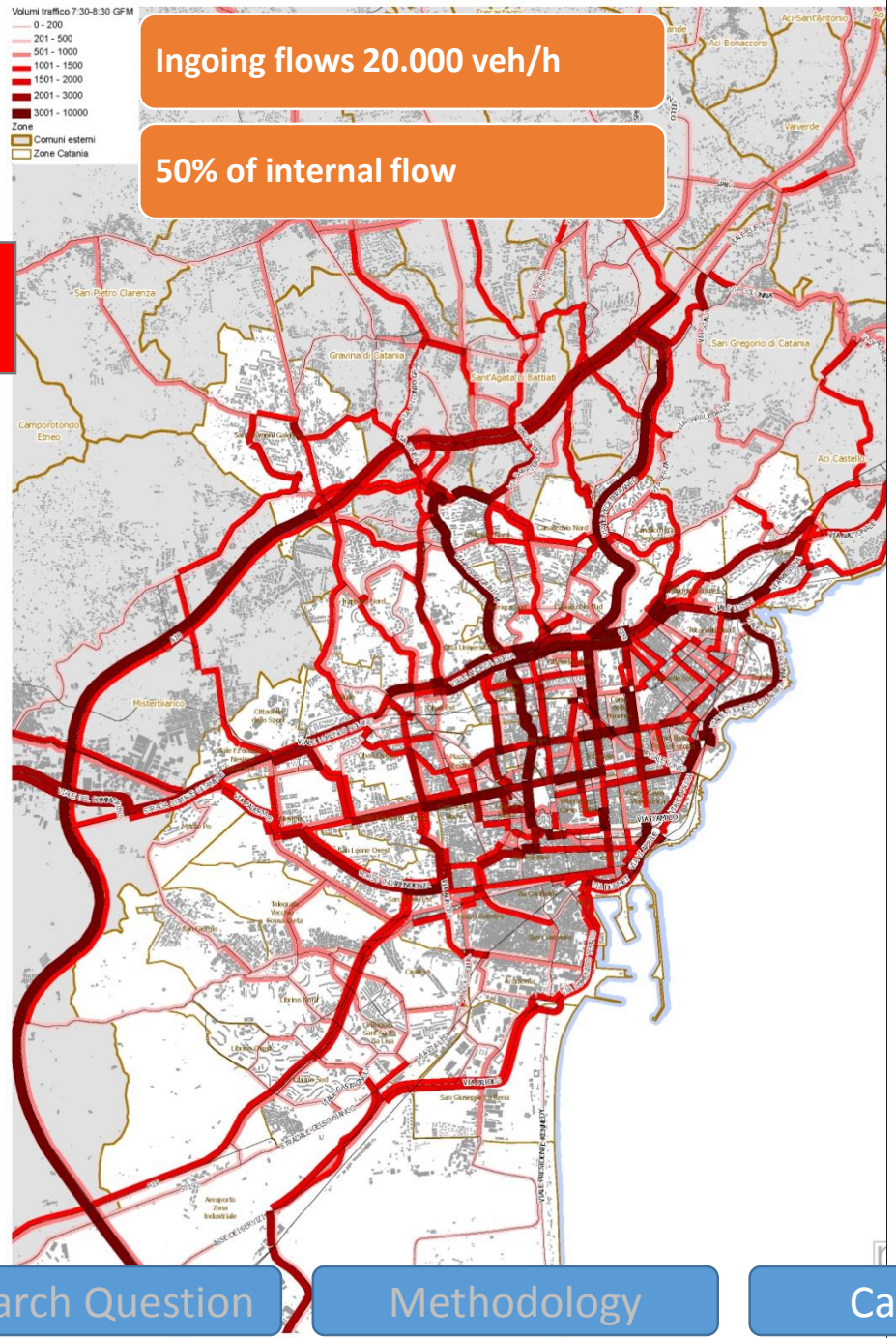
Public transport demand

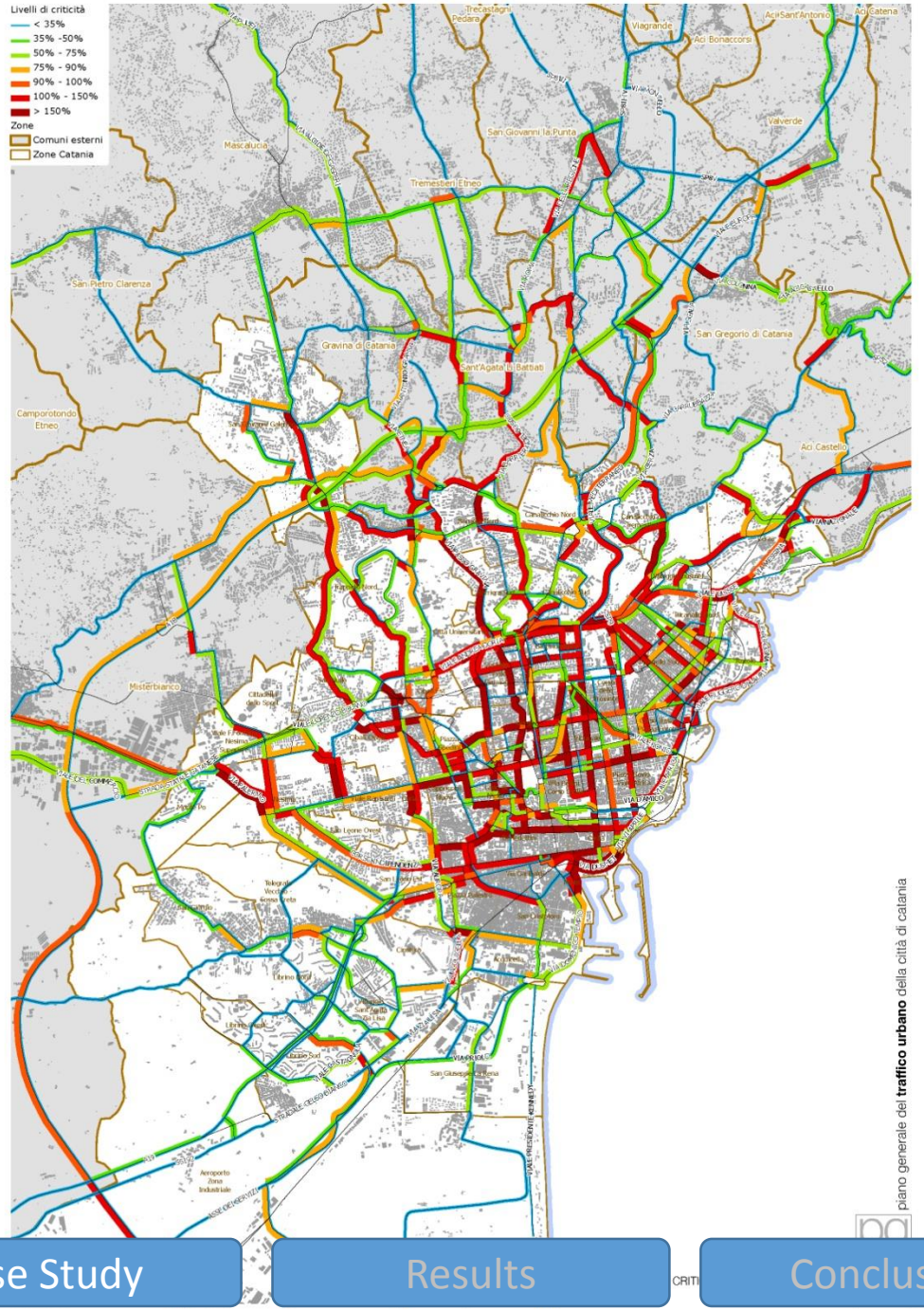
Research Question | Methodology | Case Study | Results | Conclusions

Car ownership rate (cars per 100 inh.)



Peak hour traffic flow





Road capacity saturation

Research Question | Methodology | Case Study | Results | Conclusions

Catania Transport Model

- **Transport demand**: commuting flows (5 home-to-work trips/week)
- **Transport supply**:

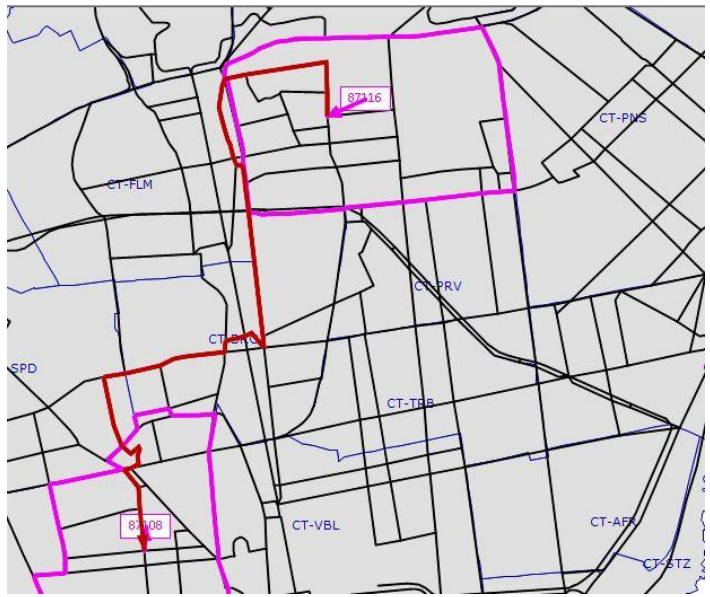
- the road network, composed of 516 nodes and 1122 links;
- the transit network considers 49 bus lines, 4 BRT lines and 1 metro line.

- **PTV VISUM** software package:

✓**shortest paths** by mode between all origin and destination pairs by all modes of transport (criterion: time)

✓option of **transit intermodality**

Shortest path by car

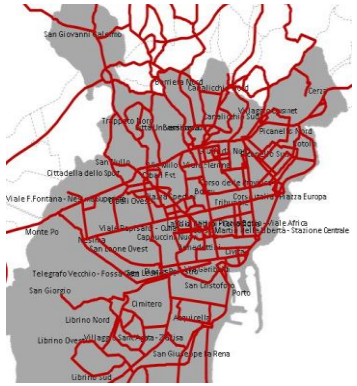


Shortest path by transit

Scenarios

Scenario 0

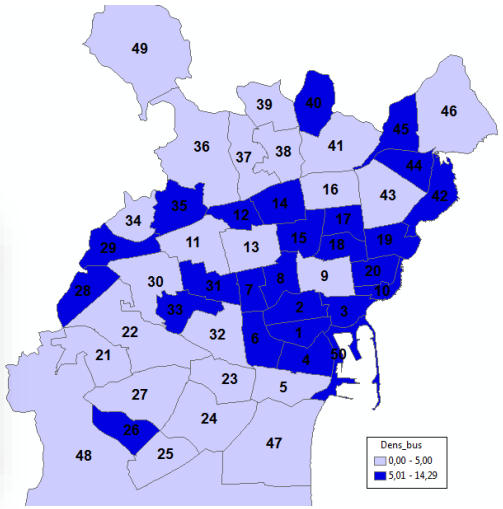
- Transit network



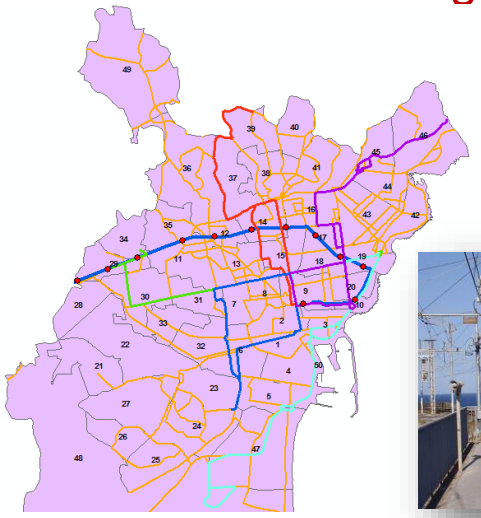
- Road network

Scenario 1: improving PT accessibility

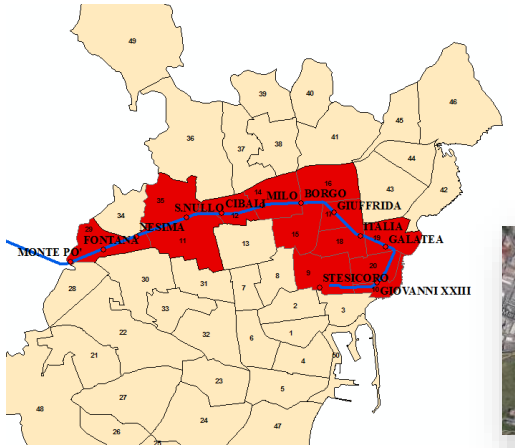
- Density threshold: 5km/km²
- 10→26 PT-covered-zones



Scenario 2: Introducing 4 BRT lines and 1 Metro line

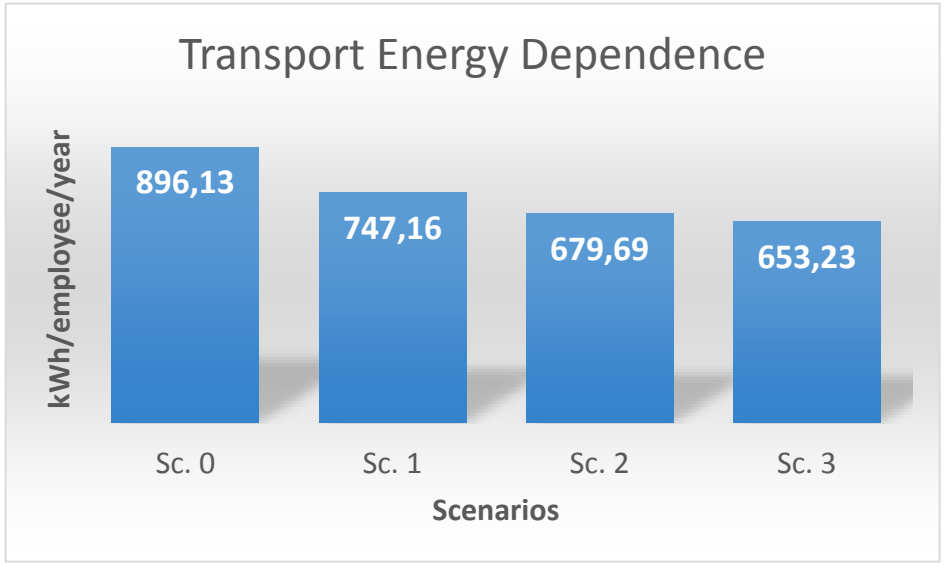


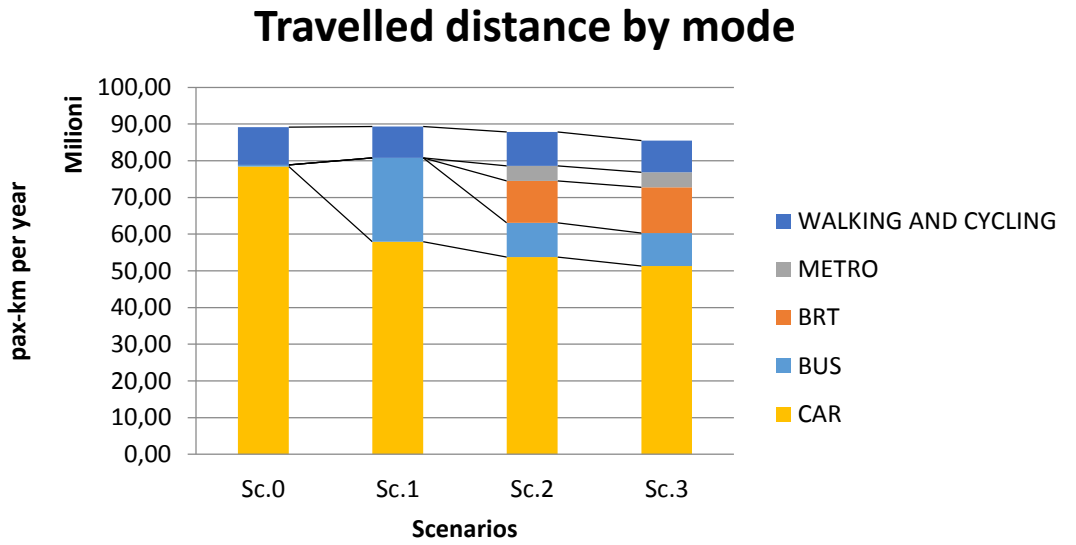
Scenario 3: Transit Oriented Development



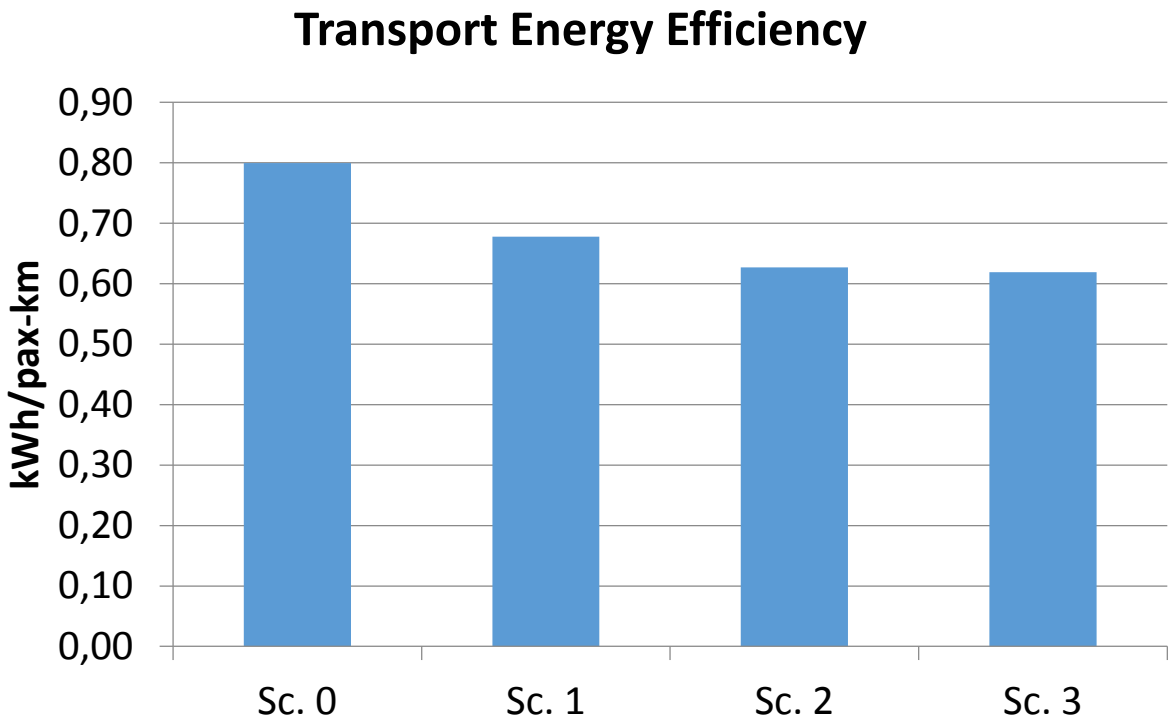
- relocating a fraction (**10%**) of residents around the stations of the metro line

Results


Transport Energy Dependence
kWh/employee/year
896,13
747,16
679,69
653,23
Sc. 0
Sc. 1
Sc. 2
Sc. 3
Scenarios


Travelled distance by mode
pax-km per year
Milioni
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
Sc.0
Sc.1
Sc.2
Sc.3
Scenarios
WALKING AND CYCLING
METRO
BRT
BUS
CAR

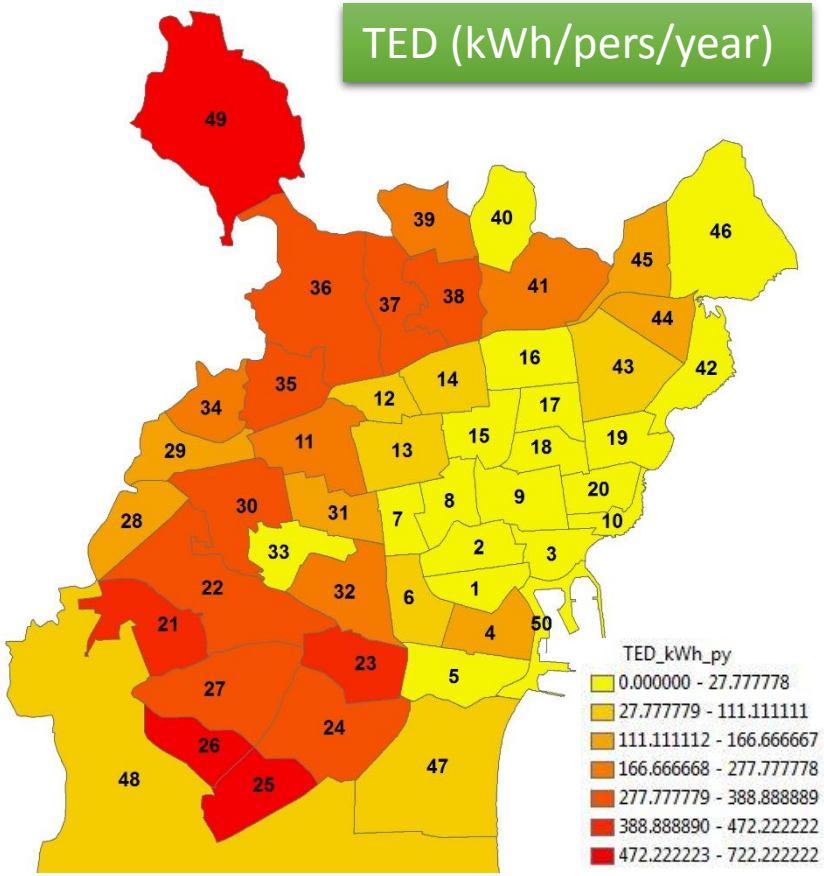
Results



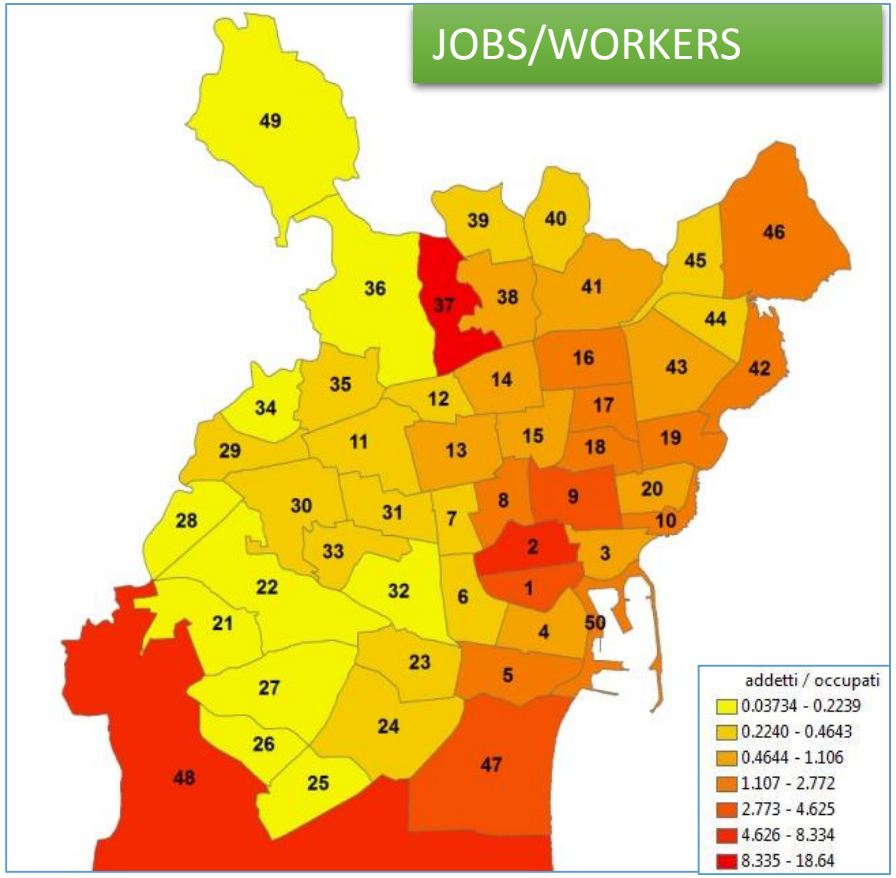
Mode of transport	Unit energy consumption kWh/pax-km
Private Car	0.917
Regular Bus Transit	0.325
Bus Rapid Transit	0.192
Metro Transit	0.133

Transport Energy Dependence by zone

TED (kWh/pers/year)

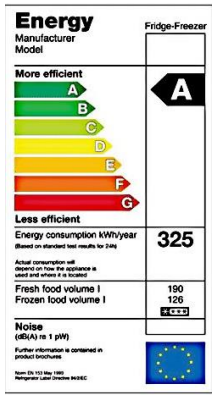


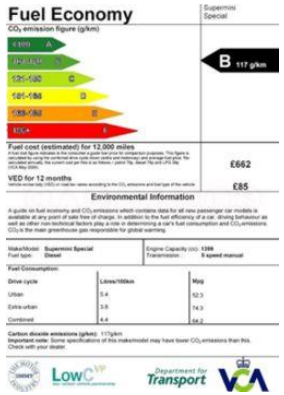
JOBS/WORKERS

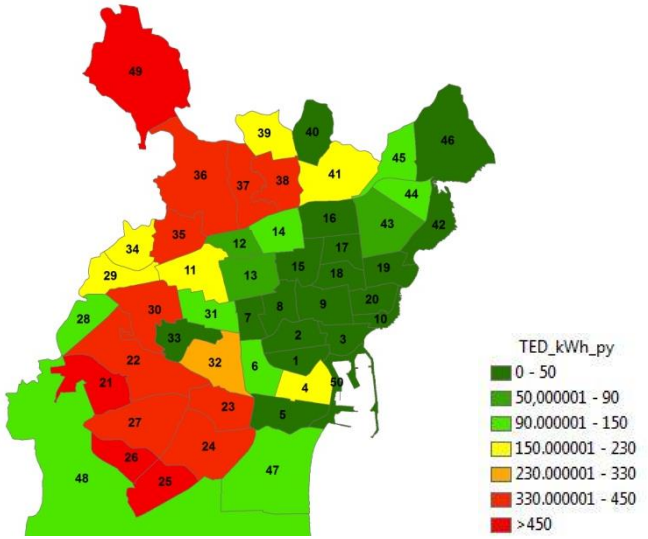


Jobs/Workers balance reduces the Transport Energy dependence

Conclusions







ACKNOWLEDGMENTS

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UNIVERSITÀ degli STUDI di CATANIA

Co-funded by the Intelligent Energy Europe Programme of the European Union

About SPECIAL

A European partnership – building the capacity of Town Planning Associations to plan and deliver sustainable energy solutions

Spatial planning has a key role to play in creating urban environments that support less energy-intense lifestyles and communities. Spatial planning and urban planners have a pivotal role in developing energy strategies and actions plans, and the SPECIAL project has been set up to help bridge the gap between climate change/energy action planning and spatial and urban planning.

http://www.special-eu.org/

Contact: ginturri@dica.unict.it

SPECIAL's key objectives

1. To build the capacity of partner Town Planning Associations (TPAs), or their equivalent, to integrate sustainable energy solutions into spatial planning training, practice and delivery.
2. To foster the exchange of experience and competence-building among national and regional TPAs, to demonstrate the integration of sustainable energy into spatial planning strategies at local and regional levels.
3. To stimulate the improved energy-related competence of town planners working within local authorities, leading to good practice examples of integrated spatial planning strategies for low-carbon towns and regions.

The SPECIAL partners

The SPECIAL partners represent the professional Town Planning Associations of their respective countries:

Austria
Provincial Government of Styria, Department of Spatial Planning Law

Germany
German Institute of Urban Affairs

Greece
Organisation for the Master Plan and Environmental Protection of Thessaloniki (ORTH)

Hungary
Hungarian Urban Knowledge Centre

Ireland
Irish Planning Institute

Italy
National Centre for Town Planning Studies

Sweden
Swedish Society for Town and Country Planning

UK
Town and Country Planning Association (TCPA)

SPECIAL...

To find out more about SPECIAL, visit www.special-eu.org or contact:

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