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NODE

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Method for energy balance for a transportation hub and its neighbourhood

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Introduction

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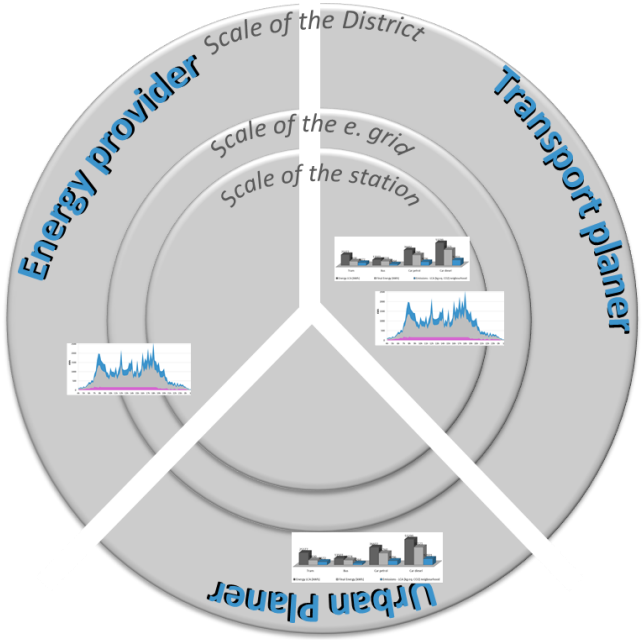
Context

- Pressure on the residential market and for service and commercial location: promotion of the public transport via Transport Oriented Development (TOD)
- Optimizing transport infrastructure
- High energy consumption in intermodal hubs and their immediate neighbourhood
- Potential for developing intelligent energy problems (production, distribution)

How to improve energy efficiency in a transport hub?



Aims

Bring together different stakeholders:

- Urban planners
- Transport planners
- Energy providers

➢ Distinct points of view generating knowledge for governance

➢ Help decision of different policies

Method

Method: dynamic approach

Technical model

- Brotchies: Costs, urban area, transport network (Macro)

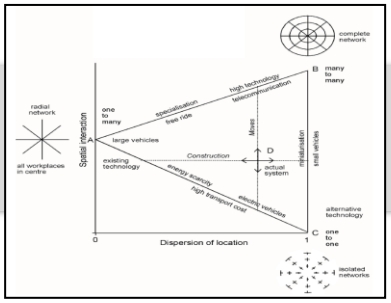


Figure 4: Brotchies' Triangle

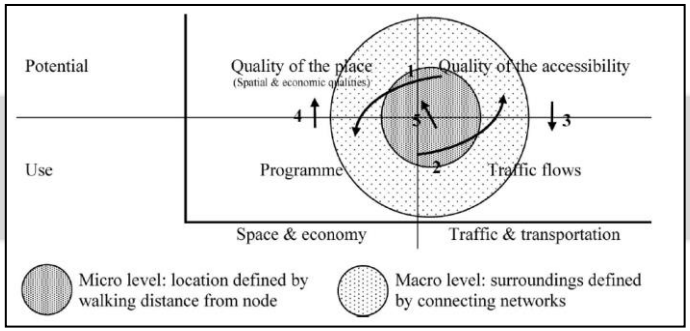


Figure 6: Multi-scales
Sources: Brand-van Tuijn 2001

Qualitativ model

- Van-Tuijn

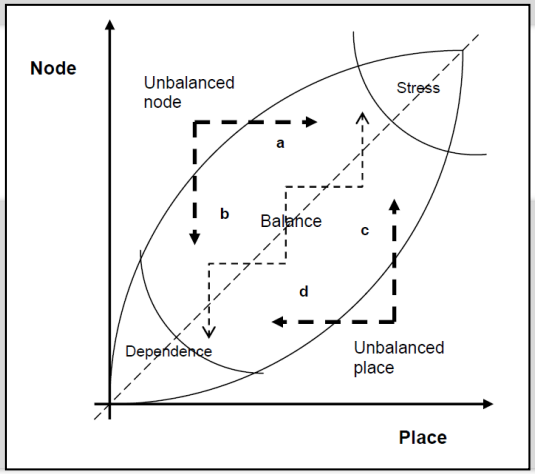


Figure 5: Node description according to influence and quality
Sources: Bertolini 2006 / 2009

LUTI

- Wulfhorst: Sensitivity model SUTRA
- Bertolini: « concern synergy model »
- Hourglass
- Chester ITLU-LC

- The simulation method: system dynamic
- A prospective approach: scenarios

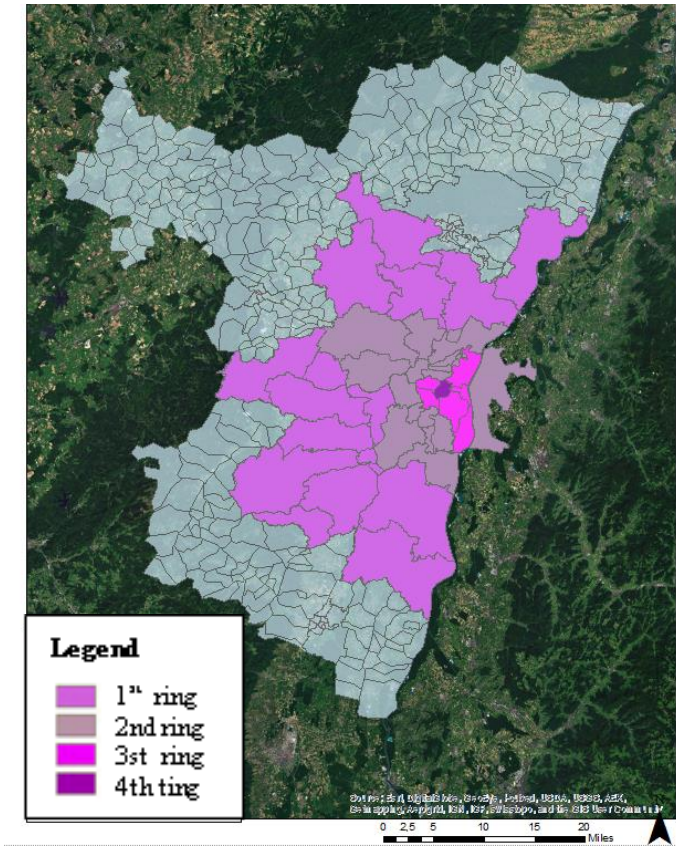
Method: Perimeter

How to focus on the station and its perimeter?

- Trips from and to the station
- Trips from and to the neighbourhood
- Scale of local electricity system (substation, transformer)

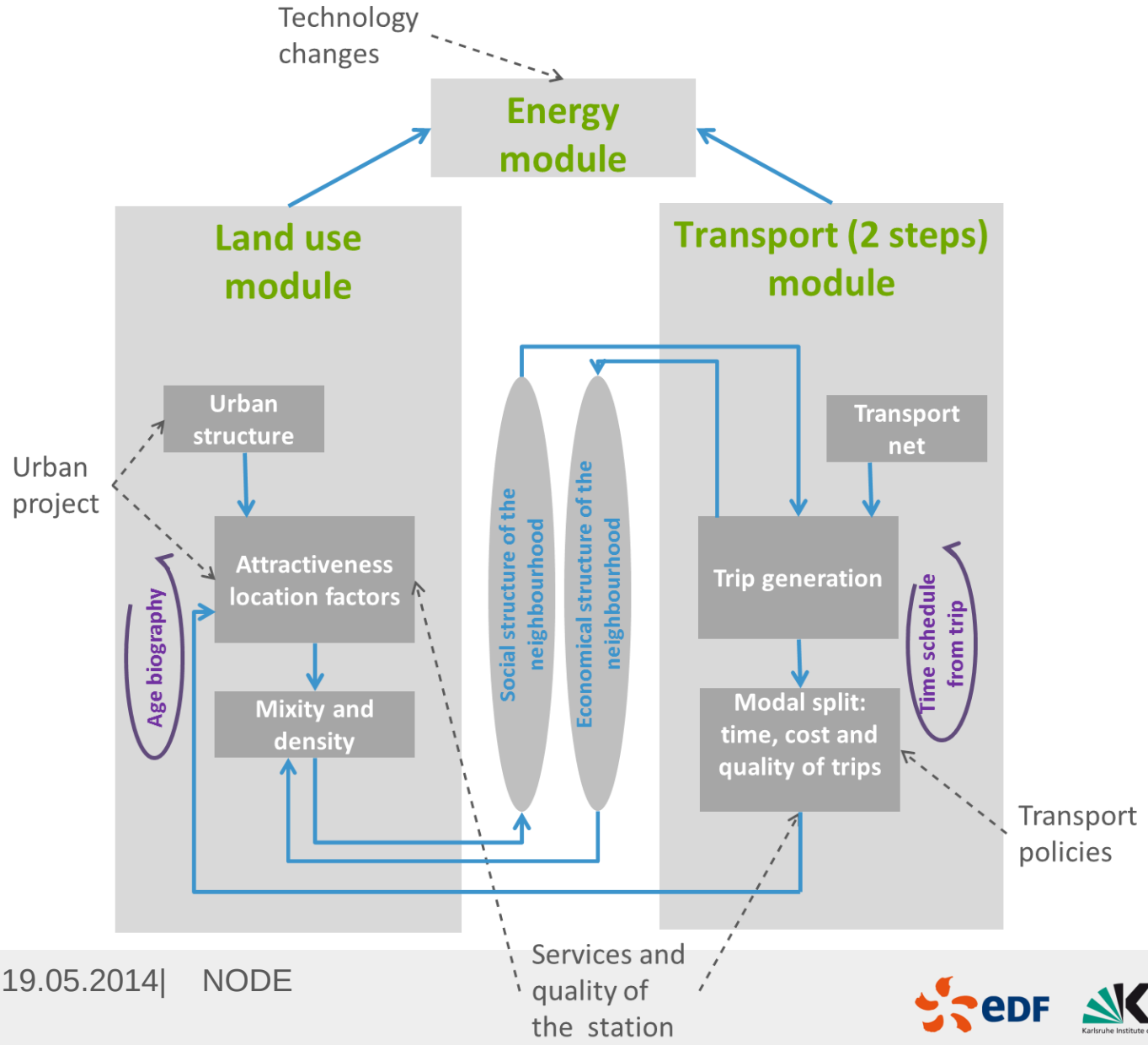
How to take into account the context of the agglomeration?

- Distinction by rings with homogeneous urban structure
- Supposing homogeneous behaviours within the ring
- Generic parameters



Strasbourg region and rings

Method: model architecture



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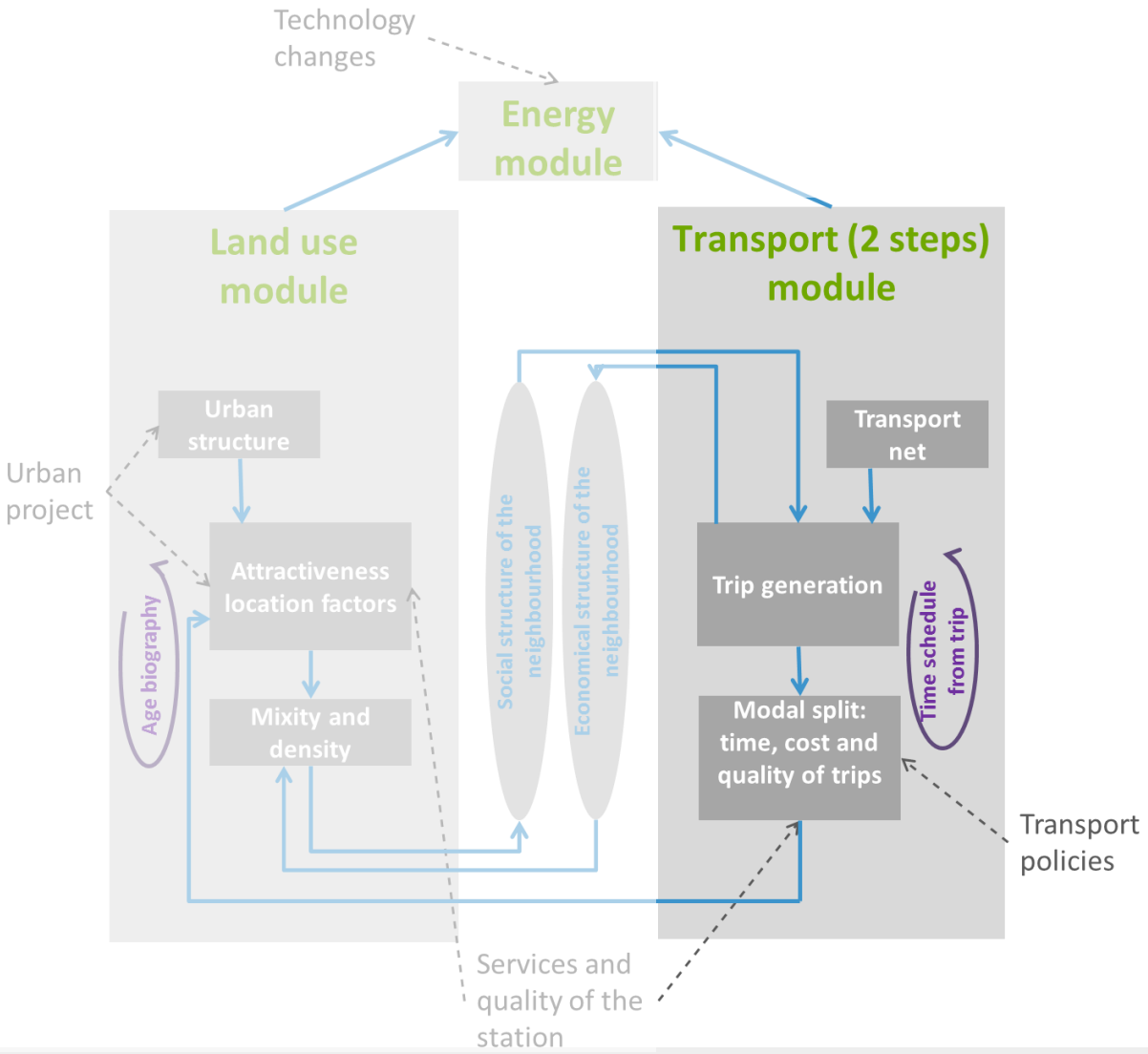
The three modules and their interactions

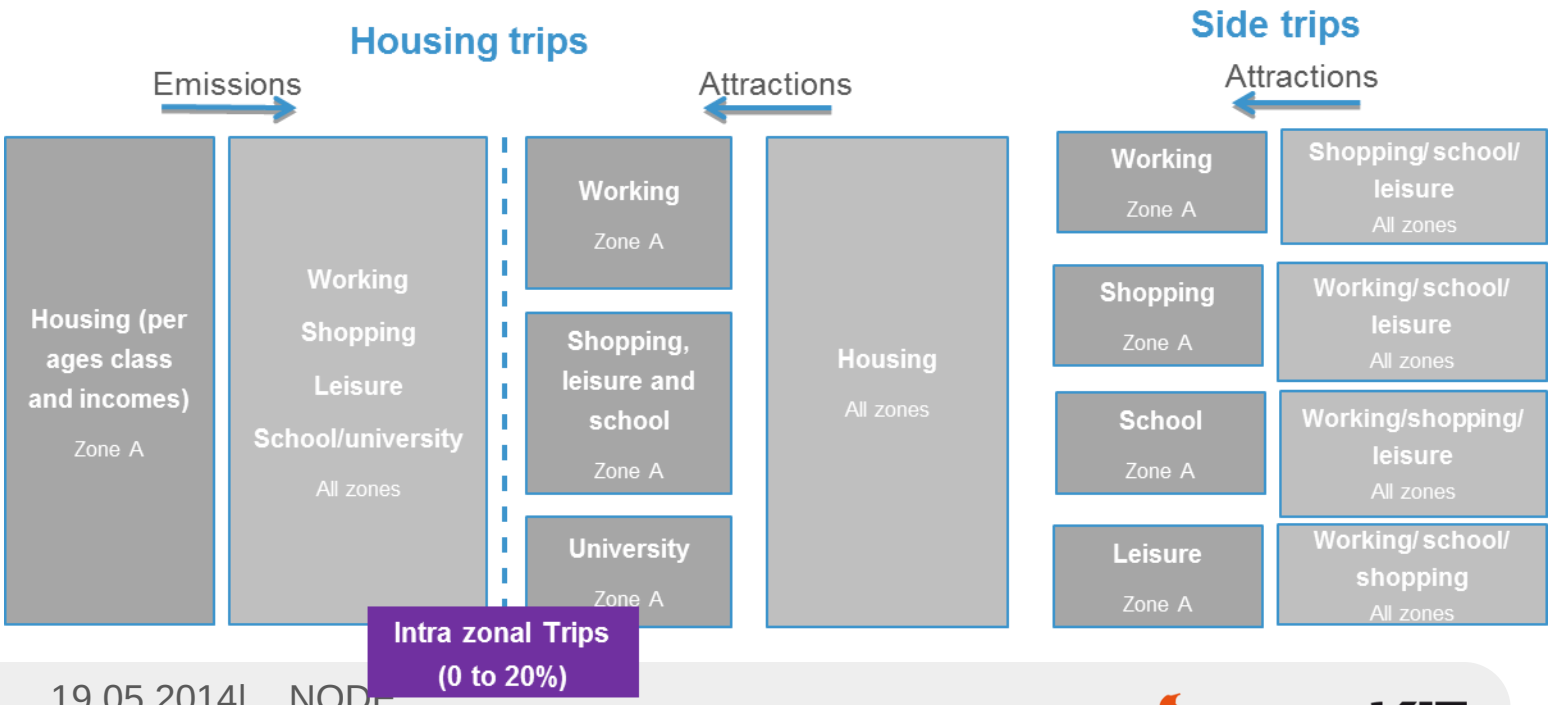
NODE Model: Transport



NODE Model: Transport

Generation

- Emissions and attractions for one zone
- Emissions (parameter from EMD analysis) and attractions (parameter from Bosserhof , 2013)
- Input data:
  - > Inhabitants with social distinctions: age and income
  - > Surface build per activity: working; shopping, leisure and school; university



NODE Model: Transport

Modal choice

- Combinations of 2 modes (feeder/main mode or main mode/last km) or unimodal
- Utility Functions

$$U_n(i) = \alpha + \sum_i \beta_i Ti + \sum_i \gamma_i Ci$$

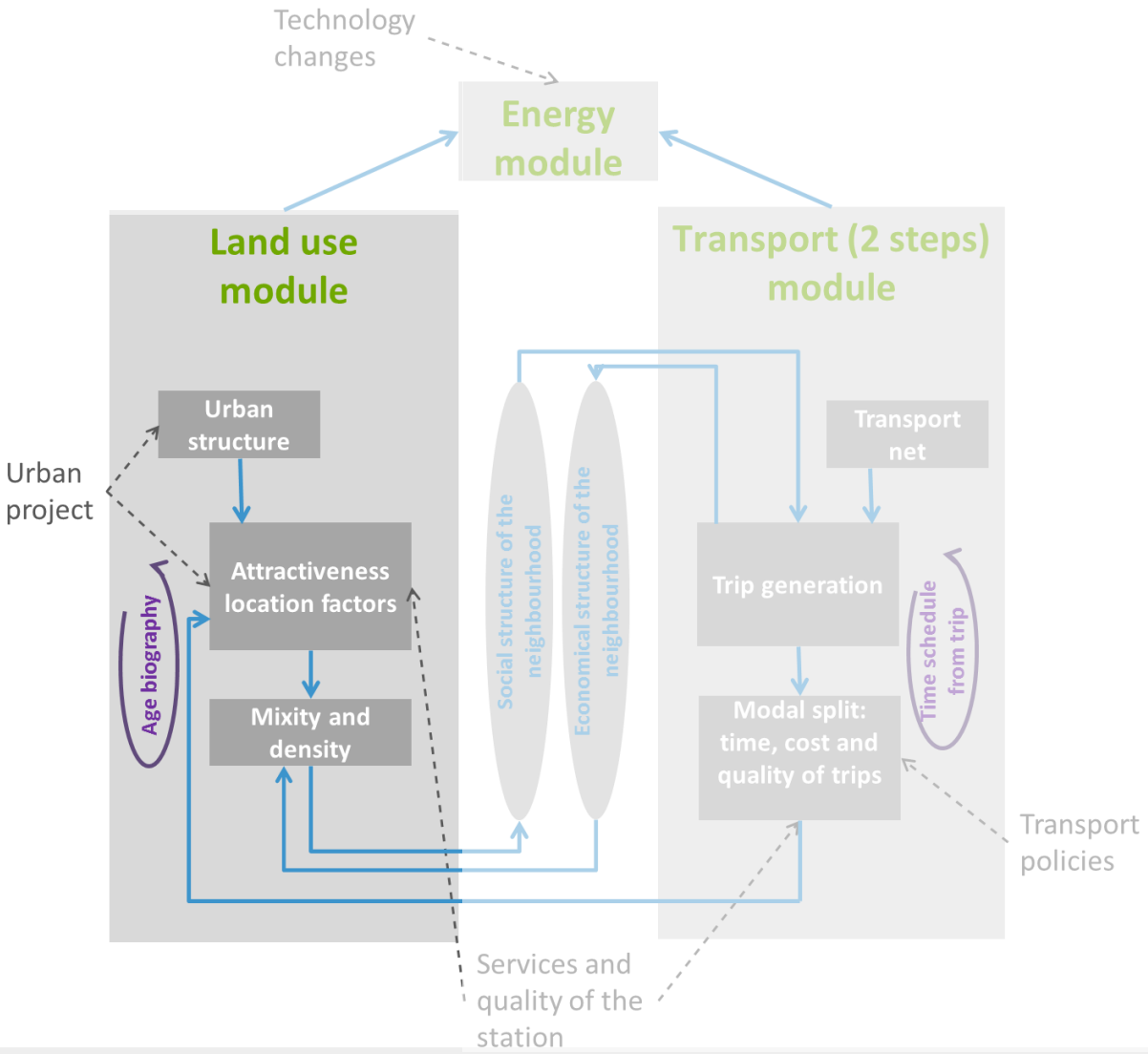
- α,β,γ: coefficients
- C: cost of the whole trip
- T: time of the whole trip
- i: each part of a trip

- Probability (Logit)

$$P_n = \frac{e^{U_n}}{\sum_k e^{U_n}}$$

- Time distribution along the day, per quarter
- Taking into account public transport frequencies

NODE Model: Land Use



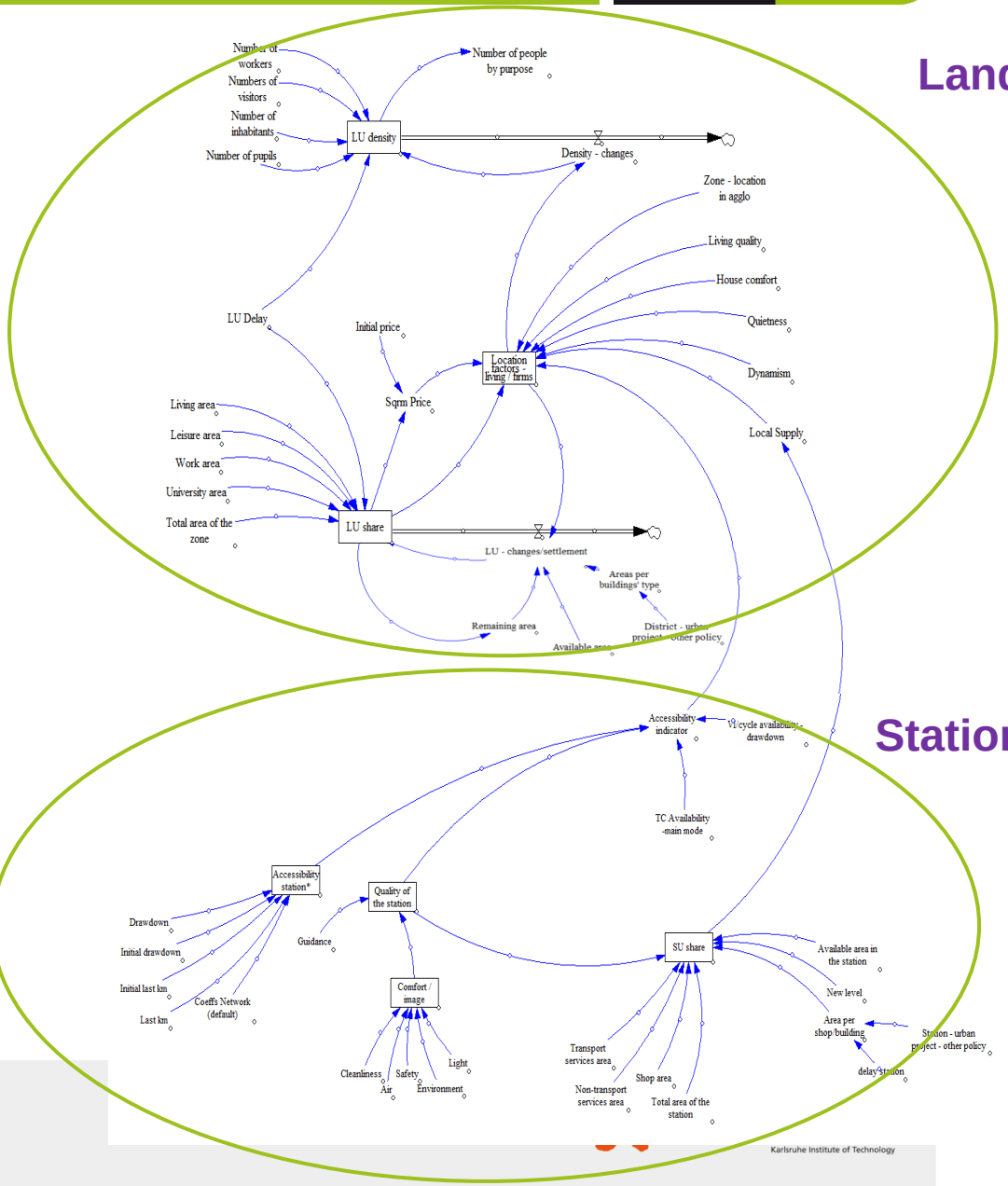
NODE Model: Land Use SD

Land Use

- Evolution of density/share
- Relocation of people is the main natural change
- Urban projects

Station use

- Dynamism of the station is a urban project (external change)
- Impacting the Land Use via the changes on local supply



NODE Model: Land Use

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Locations factors for living purposes

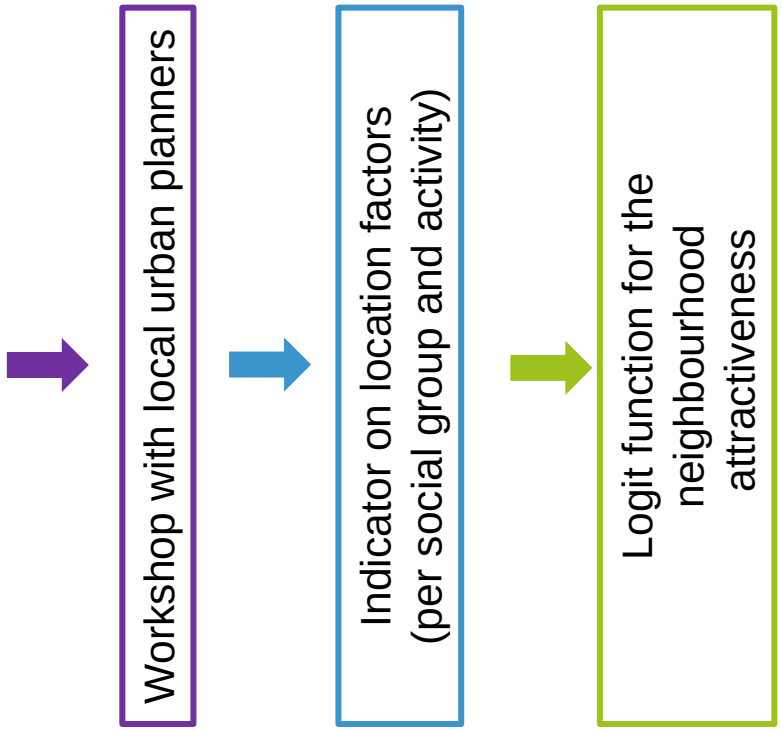
- Quiet safety
- Local supply
- Living quality
- House comfort
- Car accessibility
- The cost of land or rent

Each distinguished group is associated with a different location factor rank

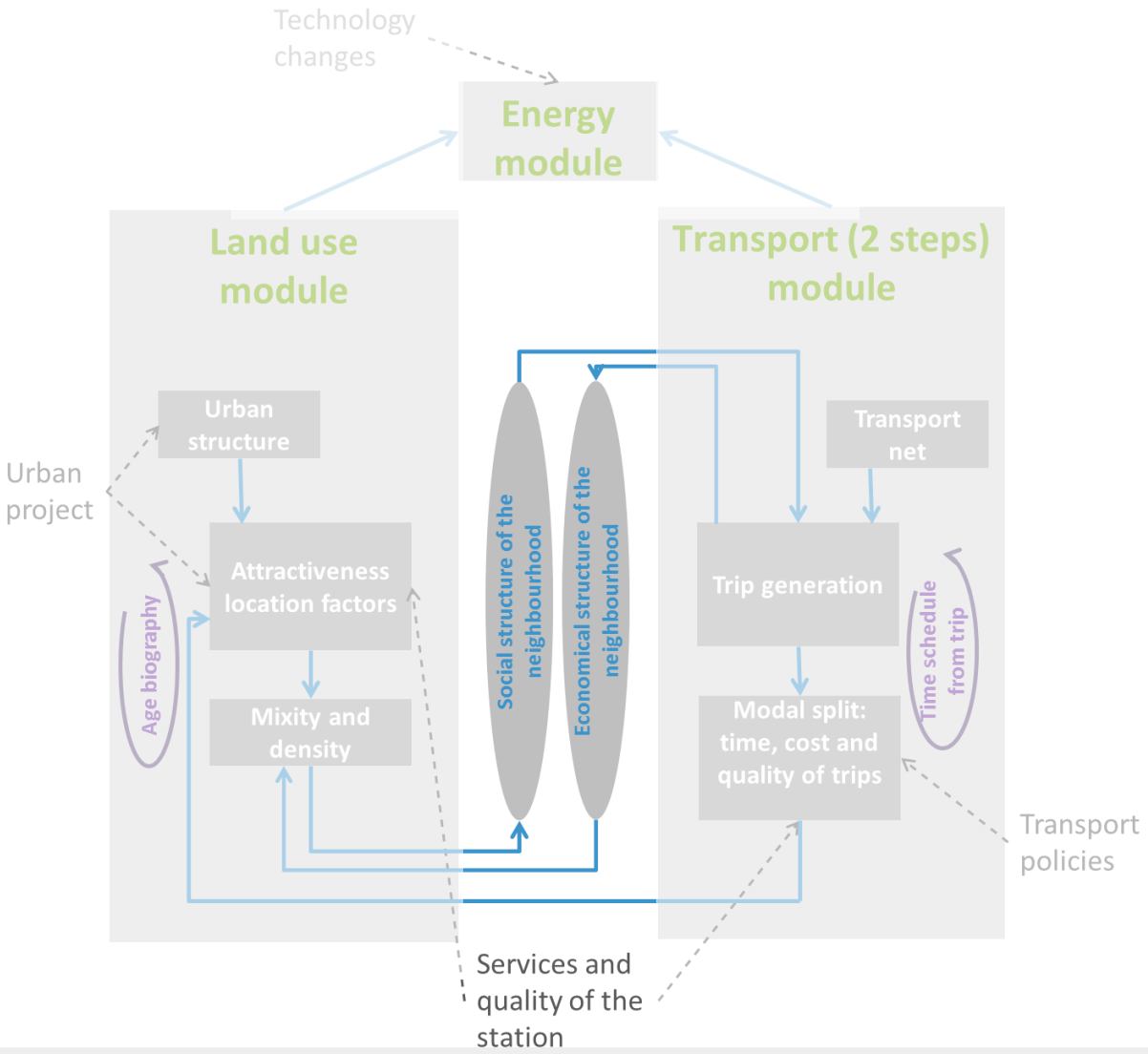
Location factors for companies

	Industry	Construction industry	Business	Transport und logistic	Services
1	Qualification of employees	Surrounding firms / Image	Land price and available area	Employees cost	Surrounding firms / Image
2	Local taxes	Incentive	Local taxes	Local taxes	Qualification of employees
3	Energy water	Employees cost	Qualification of employees	Infrastructure	Incentive
4	Employees cost	Infrastructures	Employees cost	Quality of services	Employees cost
5	Availability of employees	Qualification of employees	Public transport accessibility	Availability of employees	Land price and available area

Source: Menzl, 2009



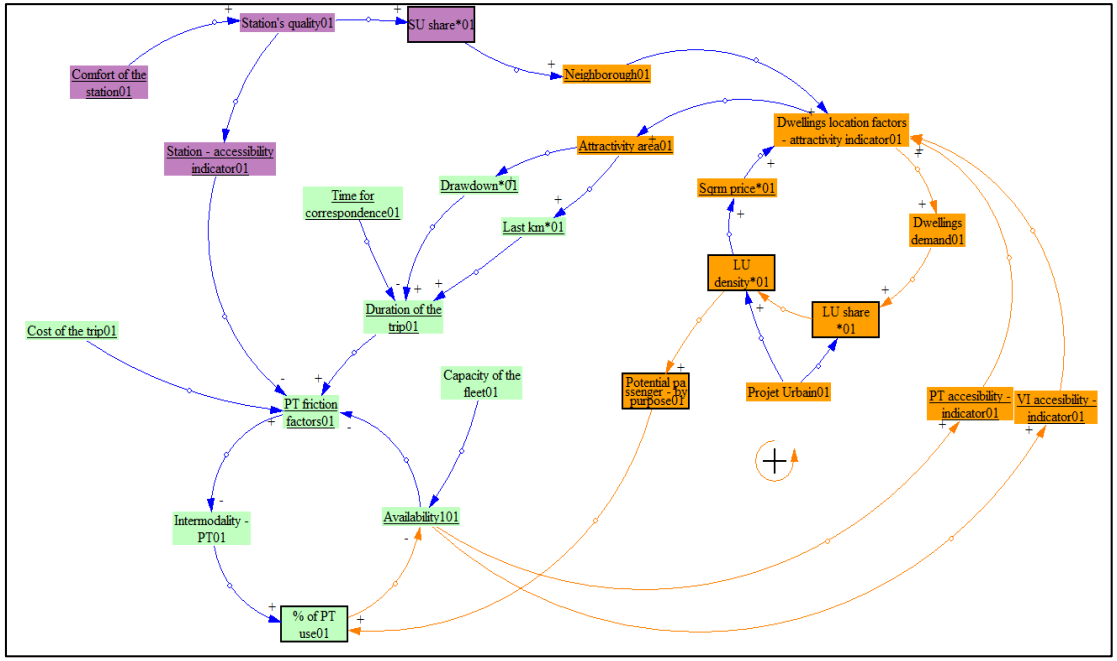
NODE Model: LUTI



NODE Model: Interaction (LUTI)

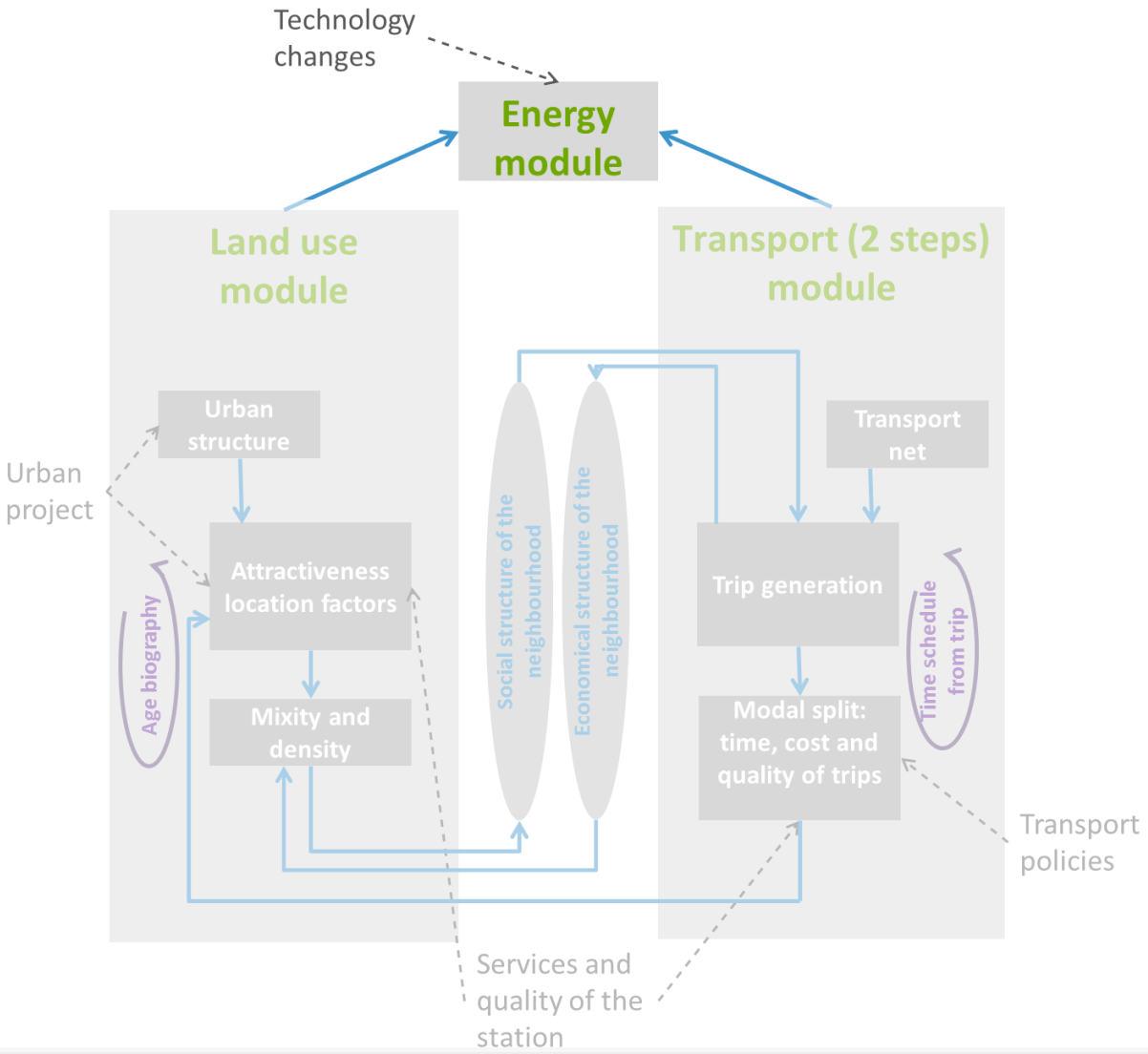
Loops

- Land Use: Neighbourghood (long term evolution) / Station (planned evolution project)
- Transport – modal choice and fleet evolution (transport project)
- LUTI (links: accessibility and attractiveness)



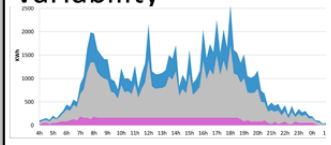
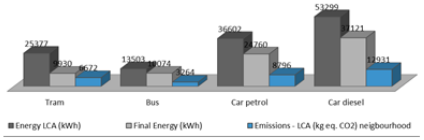
Preliminary interaction between the modules transport and Land Use

NODE Model: LUTI



NODE Model: Energy

Balances

Perimeter of different energy balances	Final energy balance	Balance of services LCA			
Objective	Energy management Impact on energy production and distribution	Comparison between modes	Comparison between station organization	Comparison between technologies	Comparison between different urban projects
Scale	Electricity Grid „Substation“, „transformer“	Of the trip	Of the station	Of the neighbourhood	Of the neighbourhood
Time schedules	Variability 	For all day, for all week or seasons 			

NODE Model: Energy

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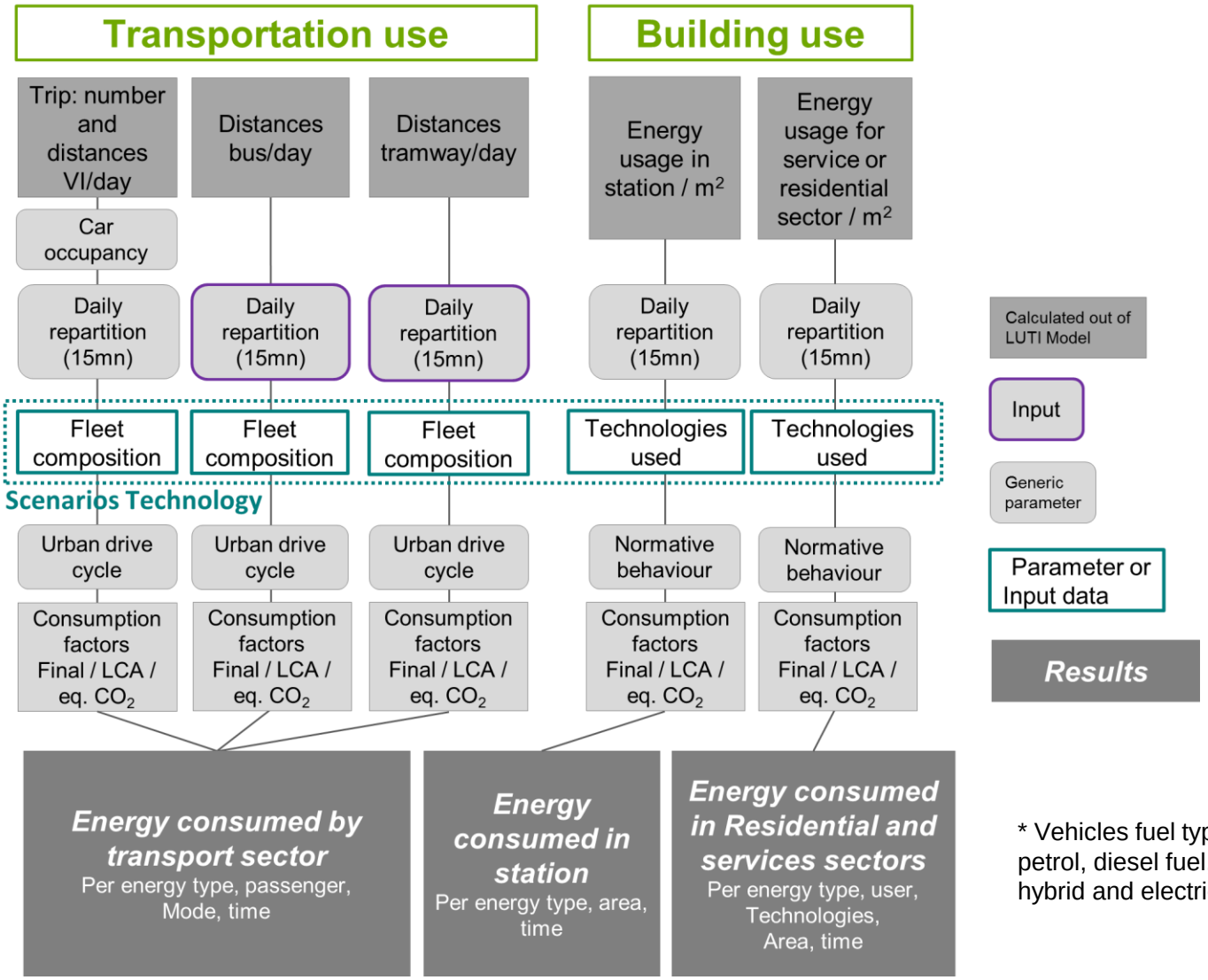
Computation



* Vehicles fuel types: petrol, diesel fuel, hybrid and electricity

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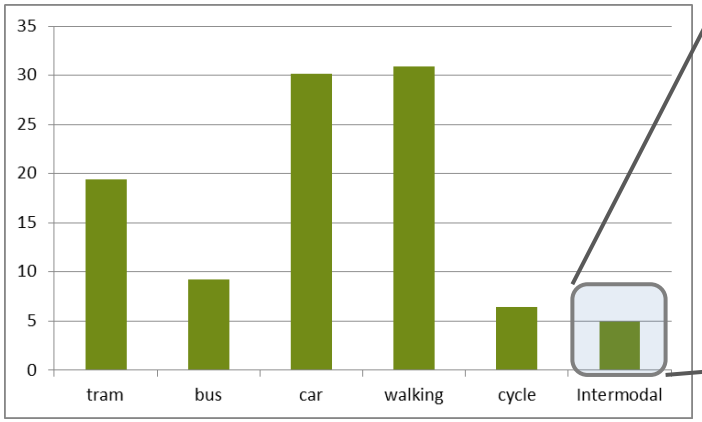
Application on Rotonde station (Strasbourg)

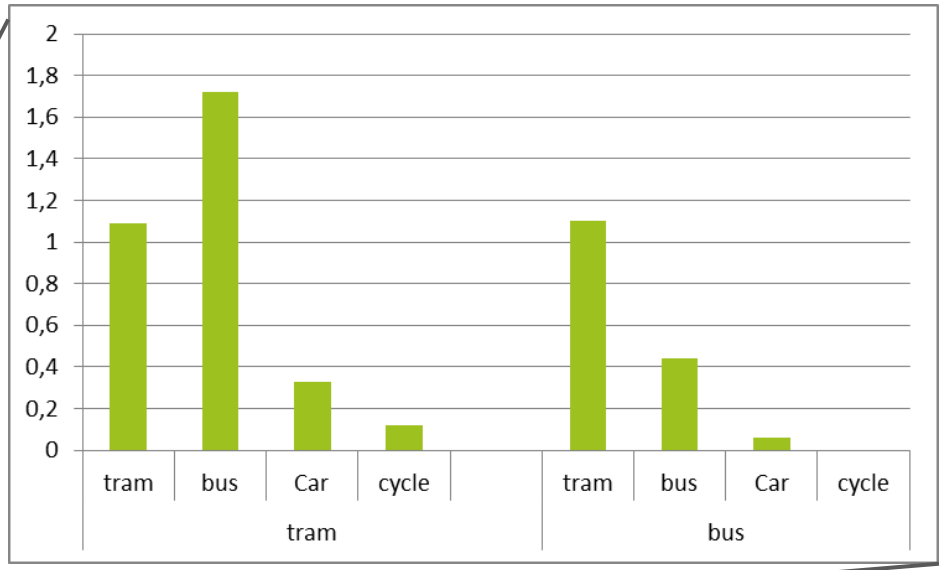
Application on Rotonde station

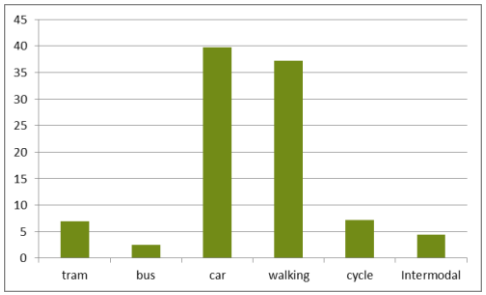
Location and urban structure of Cronenbourg Est and the station Rotonde, Strasbourg

Result: Modal Split

Rotonde modal split (neighbourhood)

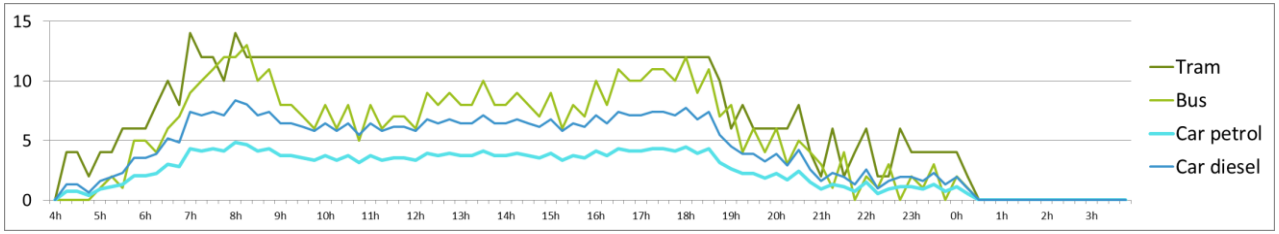




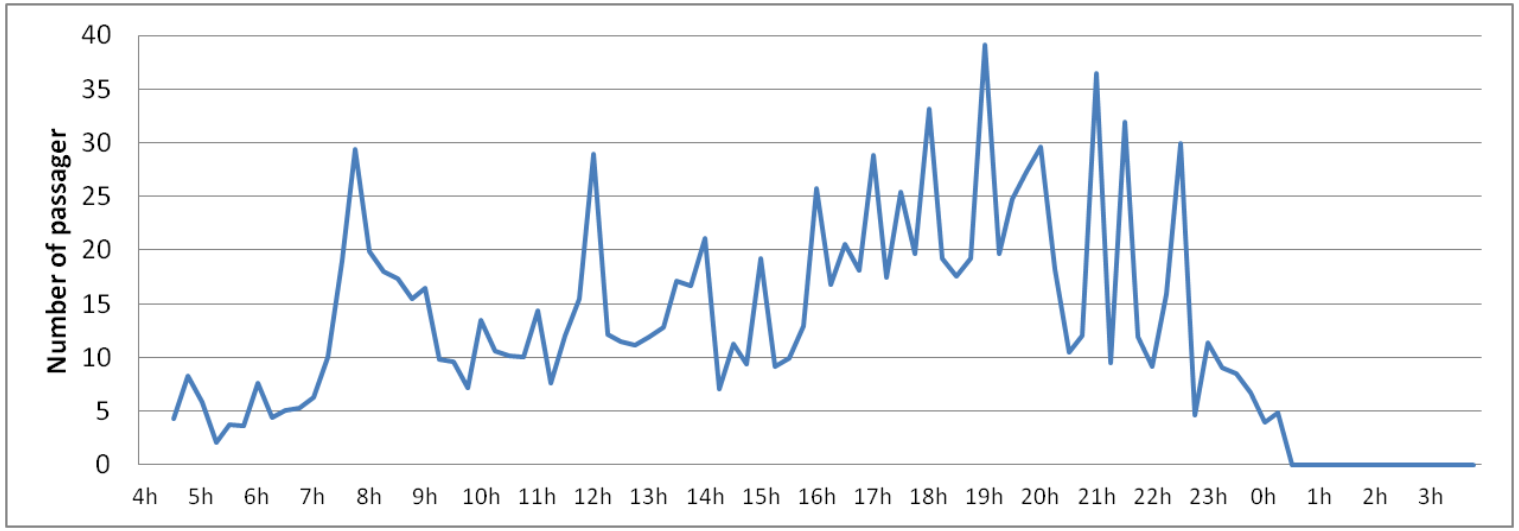


Modal split (2nd ring)

Results: station



Number of vehicles from and to Rotonde Station (PT + feeder + last km)



Passenger per tram at Rotonde Station (boarding and arriving)

Result CO2 eq. bilance

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Station

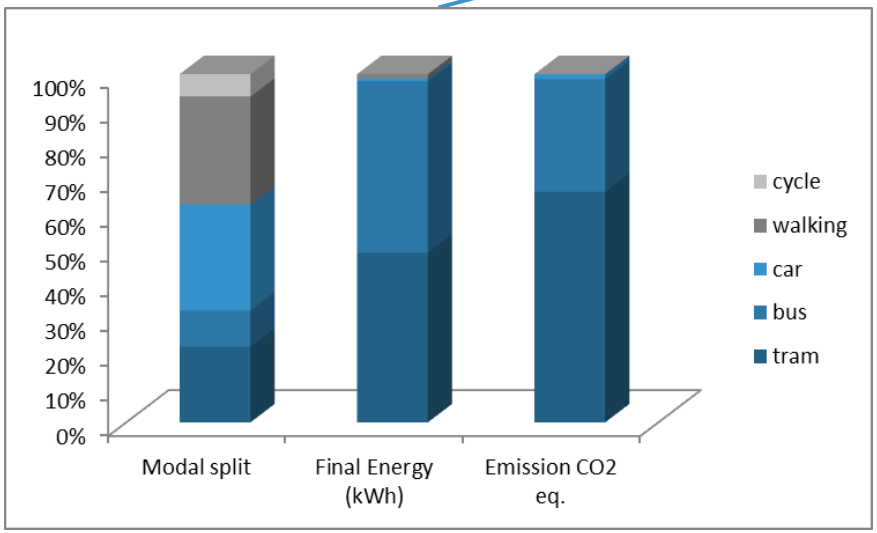
Final Energy 20423 kWh

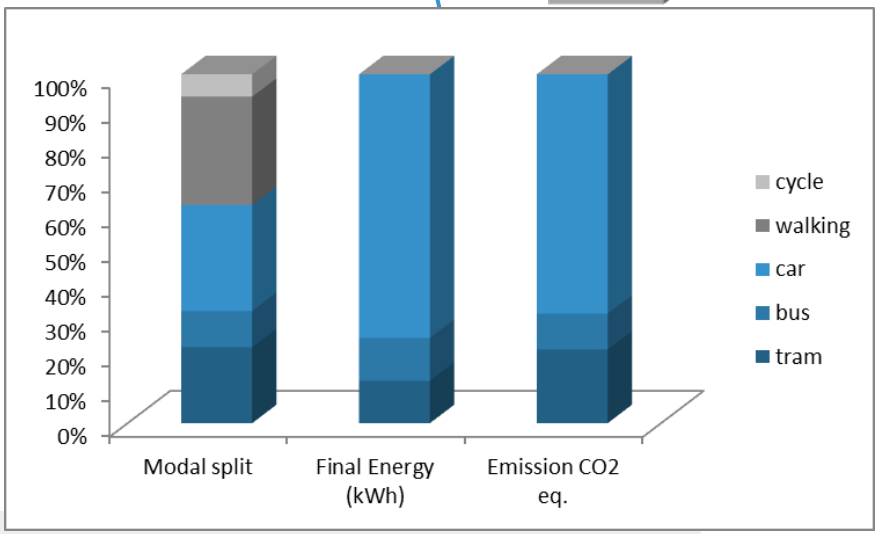
Emission 10083 kg CO2 eq.

Neighbourhood

Emission 31663 kg CO2 eq.

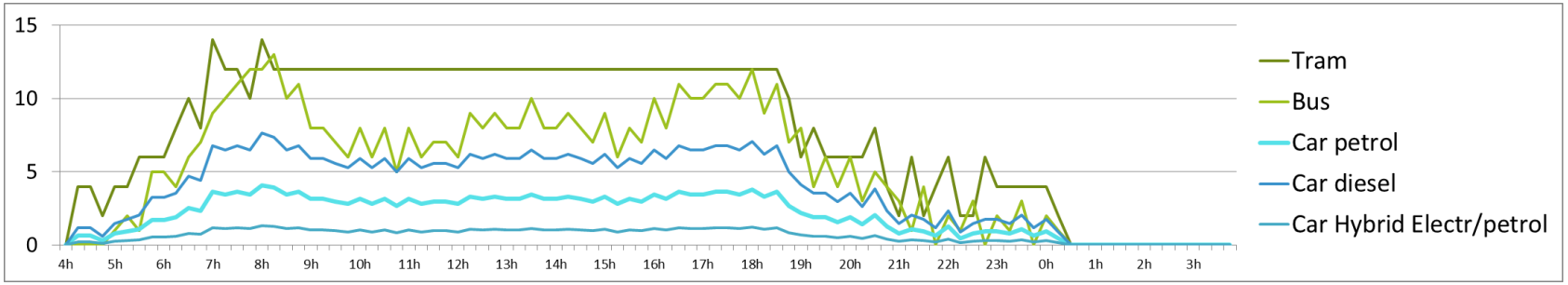
Final energy 81885 kWh



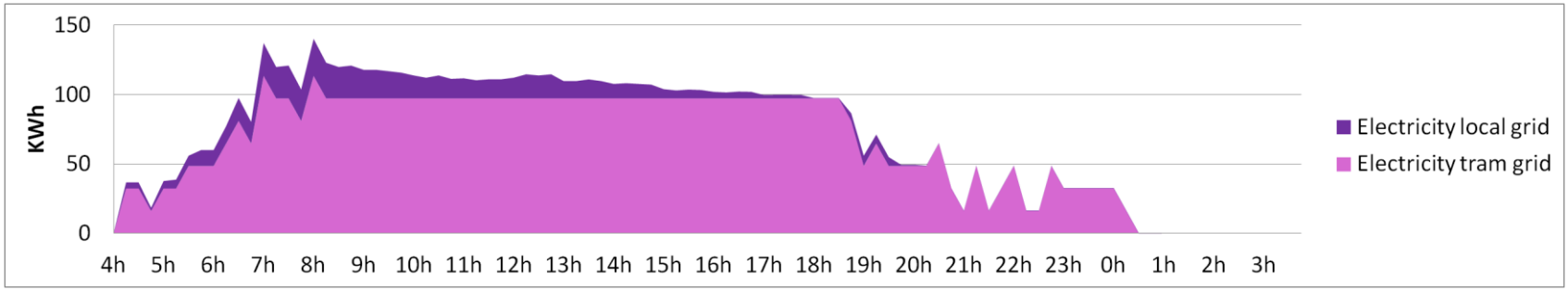


Results: final energy electric grid

Scenario with 10% electric vehicle



Trip from and to Rotonde Station with 10% of electric vehicles



Final energy consume of the trip from and to Rotonde Station with 10% of electric vehicles

Questions?

Contact

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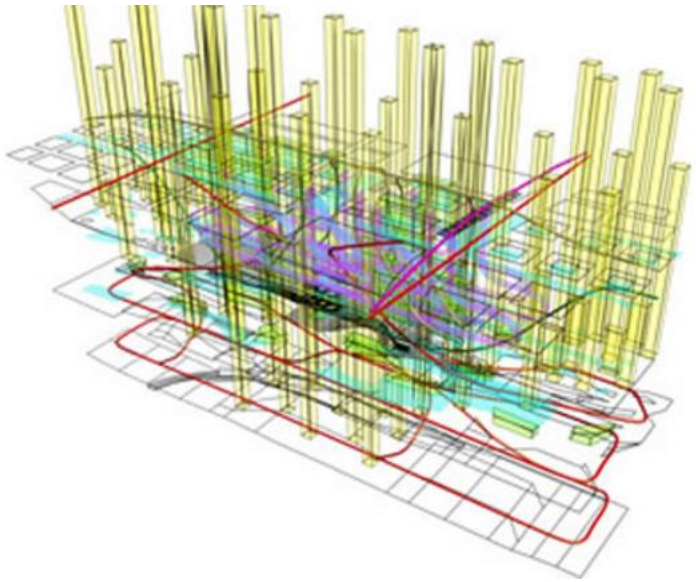
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