Method for energy balance for a transportation hub and its neighbourhood
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Introduction

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)

Qualitativ model
- Van-Tuijn

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

Energy module

Land use module
- Urban structure
- Attractiveness location factors
- Mixity and density

Transport (2 steps) module
- Transport net
- Trip generation
- Modal split: time, cost and quality of trips

Technology changes

Urban project
- Age biography

Transport policies
- Time schedule from trip

Services and quality of the station
NODE
The three modules and their interactions
NODE Model: Transport

Technology changes

Energy module

Land use module

Transport (2 steps) module

Urban structure

Attractiveness location factors

Mixity and density

Social structure of the neighbourhood

Economical structure of the neighbourhood

Trips generation

Modal split: time, cost and quality of trips

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Age biographic
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
Modal choice

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

\[ U_n(i) = \alpha + \sum_i \beta_i T_i + \sum_i \gamma_i C_i \]

- Probability (Logit)

\[ P_n = \frac{e^{U_n}}{\sum_k e^{U_n}} \]

- \( \alpha, \beta, \gamma \): coefficients
- \( C \): cost of the whole trip
- \( T \): time of the whole trip
- \( i \): each part of a trip

- Time distribution along the day, per quarter
- Taking into account public transport frequencies
NODE Model: Land Use
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
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

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

Source: Menzl, 2009
NODE Model: LUTI

Energy module

Land use module
- Urban structure
- Attractiveness location factors
- Mixity and density

Transport (2 steps) module
- Social structure of the neighbourhood
- Economical structure of the neighbourhood
- Trip generation
- Modal split: time, cost and quality of trips

Technology changes

Urban project

Services and quality of the station

Transport policies
Loops

- Land Use: Neighbourhood (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

Energy module

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Transport policies
- Time schedule from trip

Services and quality of the station
## Balances

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<th>Final energy balance</th>
<th>Balance of services LCA</th>
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<tr>
<td><strong>Objective</strong></td>
<td>Energy management impact on energy production and distribution</td>
<td>Comparison between modes</td>
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<tr>
<td><strong>Scale</strong></td>
<td>Electricity Grid „Substation“, „transformer“</td>
<td>Of the trip</td>
</tr>
<tr>
<td><strong>Time schedules</strong></td>
<td>Variability</td>
<td>For all day, for all week or seasons</td>
</tr>
</tbody>
</table>

![Graph showing variability over time](image)
NODE Model: Energy

Computation

Transportation use
- Trip: number and distances VI/day
  - Car occupancy
  - Daily repartition (15mn)

Building use
- Distances bus/day
- Distances tramway/day

Energy consumed by transport sector
- Per energy type, passenger, Mode, time

Energy consumed in station
- Per energy type, area, time

Energy consumed in Residential and services sectors
- Per energy type, user, Technologies, Area, time

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

Station
- Final Energy: 20,423 kWh
- Emission: 10,083 kg CO2 eq.

Neighbourhood
- Emission: 31,663 kg CO2 eq.
- Final energy: 81,885 kWh

Modal split
- Cycle
- Walking
- Car
- Bus
- Tram
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?

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