NODE: methodology for energy balance for a transportation hub and its neighbourhood

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Context motivation and questions:
Locating urban development projects near transportation hubs could offer solutions for planners addressing urban sprawl (environmental problems) and re-urbanisation process (real estate difficulties) (Renne, 2007; Wells, Renne, 2003). Intermodal hubs and their immediate neighbourhoods consume a lot of energy however, the potential for developing transport hubs to address urban energy problems (production, distribution and efficiency) has not yet been analysed (Peny, 2012).

The NODE research project, lead by EIFER, primarily addresses the questions of how to improve energy efficiency in a transport hub. Will the development of new transport technologies significantly reduce energy consumption or, will it mostly result in the substitution of one energy for another? To what extent does neighbourhood density and diversity of use influence energy efficiency?

The NODE project aims to bring together different stakeholders like urban planners, transport planners and energy providers, each with a distinct point of view and area of expertise, to generate knowledge about energy governance.

Methodology
A system dynamics (SD) modelling method is used because it demonstrates the interaction between different parameters of the system represented. The objective is to identify tendencies rather than to obtain a precise calculation. This method is specifically adapted to allow for change in perspective and to gain an integrated view between sectors. The NODE model uses VENSIM software.

The model requires tree modules: “transport module” and “land use module” evolve simultaneously by changing the number and the profile of public transport users. Changes over time are derived from feedback between the accessibility of the station by public transport and the quality of life, which increases the attractiveness of the neighbourhood. Furthermore, any changes to transport and services at the station will have an impact both on public transport use and on the attractiveness of the neighbourhood.

The application of a LUTI method on a micro level implies some methodological particularities. First, the location of the hub within an agglomeration will be taken into account by applying different parameters like distance to the city centre, attractiveness and accessibility. Second, the population is classified by age and income, this allows for differences in transportation behaviour and in location preferences.

For the transport module, two steps are implemented:

1. Generation: The generation table is organised into two types of trips: “attractions” and “emissions”. “Emissions” are supposed to be homogeneous within demographic

groups (age and income) for one area, and their origin is always the home, irrespective of their purposes. “Attractions” are concerned with destination area and different purpose.

2. Modal choice: The modal choice is based on the economic utility for people. The main objective is to take into account the multimodal choice for each trip, because research at a hub is focused on multi-modality (PREDIT, 2002). A chain of trips is not decided by two different choices (one at the trip beginning, one at the middle, and one at the end); travellers will first consider all possible combinations and then determine their route. The application of modal choice in Vensim takes into account the availability of different modes.

The land-use module takes into account the area around the station (neighbourhood). Surface of different uses are input data in the module. For each activity a generic parameter, explaining the density of use, if fixed. For example, the number of inhabitants is calculated from the number of square meters for “living” and the population density of the neighbourhood (generic parameter m^2/inhabitants). Calibration is realised looking at INSEE Data (number of inhabitants for the zone). For other uses like shopping, higher education and leisure, surfaces can be determined through field work as the neighbourhood covers a small area. Finally, the available area for new development is identified by SCOTER, the regional planning instrument (ADEUS, 2008).
In the land use module, two steps are implemented:

1. The model applies real estate mechanism by calculating an indicator on location factors. The quality of each location factor for the neighbourhood and for the rest of the ring will be defined during a workshop with local urban planners. The relative indicators comparing the neighbourhood to the rest of the ring will be fixed to a “function of local development”. Results over „1“ indicate growth in the neighbourhood whereas results below „1“ suggest a decline. Moreover, the indicator allows for an estimation of the speed of development; the farer the indicator value is from “1”, the quicker the change because the function tends to zero and to infinity.
2. The next step is evaluating the different population groups and the type of companies that are shaping the dynamics of the neighbourhood. To identify the types of population arriving, the model applies different location factors per groups of residents (per demographic profile) and per type of company (per activity sector).

The “technology and energy module” work separately. Two forms of energy balance can be provided through application of different consumption factors: final energy and Lyfe Cycle Analyse consumption factors; thus meeting project requirements of governance.

Example of result on transport sector:
The model is applied in Strasbourg, on the “Rotonde”. The “Cronenbourg Est” neighbourhood is mixed-use, with housing (community buildings and individual houses), shops and leisure facilities, a cemetery and an administrative building.
Because of the relatively constant frequency of public transport use throughout the day, energy consumption peaks are not as significant as the distribution of passengers throughout the day. Nevertheless, morning and evening peaks can be identified.
A calculation with the LCA consumption factor per mode allows for a change of perspective. This displays the energetic dominance of the trams (electric) compared to the bus (diesel), mainly because the trams driving through Rotonde are 3 or 4 compartments long. However, it is noteworthy that the environmental impact of the bus (final energy consumption

represents 75% of LCA) is greater that of the tram (final energy represents 60% of LCA). At last, the eq. CO_2 balance of tram is much better comparing to the bus because of the use of electricity.

Conclusion

Initial results show, that it is worth continuing to work with this simulation method because it supports local authorities in planning TOD. It affords a multi sectoral approach; it enables the change of perspective between final energy and environmental balance. Different scenarios in transport, technology changes and local development will be performed.