Moving towards the sustainable city? The role of electric vehicles, renewable energy and energy efficiency

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Abstract

Integrated energy and urban mobility systems are key components for achieving cities' sustainability. Several urban metabolism approaches are emerging as leading tools for quantifying energy consumption and use patterns of resources in urban environments. Examples are the mass balance accounting (or energy-materials flux approach) using several quantification methods such as material flow analysis and life cycle assessment and Odum's emergy methods. In this research we adapt the extended metabolism model of a city developed by Newman (1999) and the material and energy flow accounting by Sheeri (2002) to assess the future role of electric vehicles, renewable energy use for mobility needs and energy efficiency increases for households living in the city of Aveiro, a medium-sized city of 78450 inhabitants in Portugal. The data used comprised an integrated set of energy, transport, socio-economic and solid waste production/treatment collected at the local and National level as part of the research project COST-TRENDS funded by the Portuguese Foundation for Science and Technology. The analysis of the potential energy mix (energy inputs from different sources) and households' mobility needs refers to the horizon 2010-2020. Several energy sources were considered: hydric, wind, solar (thermic and photovoltaic) and solid waste (incineration and biogas). Potential accessibility indicators were developed to better convergence towards sustainable mobility objectives, measuring the potential for interaction and exchange of services and opportunities. Different household's profiles were established to represent consumers' behaviour. It was found that the above integrated energy system could provide a total of 2,61 MWh/household.year, which represents on average around 38,2% of the total energy needs for households' daily mobility and 1,2 tonnes CO2/household.year avoided. On the other hand, the replacement of conventional internal combustion engine by battery electric vehicles could allow an energy reduction between 4,7 and 6,1 MWh/household.year until 2020 and a reduction of 1,6 tonnes CO2 /household.year.

Keywords: Emerging technologies (electric vehicles); transport policy and planning; Energy efficiency; CO_2 emissions; City sustainability; Urban Metabolism.